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THEORETICAL AND METHODOLOGICAL PROBLEMS

PROBLEMY TEORETYCZNE I METODYCZNE

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DILEMMAS OF INFORMATION SOCIETY AND CHALLENGES TO RESPONSIBLE DEVELOPMENT

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ABSTRACT: The concepts of information society and knowledge-based economy present a desirable direction of civilizational changes as a means for the realization of responsible socio-economic development and wisdom-based economy of the future. However, they also generate their own sets of challenges and are characterized by imperfections and barriers to development. Proper identification and reduction of these problems seem to determine the future implementation of responsible strategies of development. The authors emphasize selected challenges that may gravely affect the progress of information society and the associated new model of the economy.

KEY WORDS: an information society, knowledge-based economy, wisdom-based economy, responsible development

Introduction and research methodology

Even a cursory review of modern scientific studies related to socio-economic development and economic growth provides evidence of a great variety of concepts and approaches employed in this context. Concepts of development range from extensive to intensive, structural to resource-based, endogenous to exogenous, and they are implemented in accordance with strict trajectories of changes in fundamental indices or (as in the last few decades) affected in response to challenges in environmental, technical, technological, sociological or information-related developments. At the same time, new models are postulated in an attempt to integrate such varied aspects of the complex socio-economic process as sustainable development, sustainability, integrated and durable development and responsible socio-economic development. Each of the above postulates provides interesting conclusions, and each can be used as a source of important questions of both cognitive and applicative character.

The researchers are writing about responsible development, its necessity and effects. Infrequent, they are interested in the implementation problems of this strategy, mainly, related to an information society and knowledge-based economy. Why? It is an important and interesting question. In this paper, authors concentrated on identification of the barriers and challenges of responsible development, in literature and researcher's consciousness (Poskrobko, 2009b).

This paper addresses the idea of responsible development from the viewpoint of the information society – interpreted here both as a category of study and as a source of information/communication dilemmas and problems. The main purpose of the study is to identify those basic challenges to the idea of responsible development which are generated in association with information societies, their principles, and their institutions (in a broad definition of the term, i.e. in a sense postulated by new institutionalism or new institutional economics).

The study does not attempt to verify any specific theses or research hypotheses. The authors believe that – at least at this stage of the scientific discourse – it may be more important to pose the right questions and to identify the most important problems which can then be studied in detail with the view of determining their conditions and, ultimately, postulating viable solutions.

Although the problem addressed in this study escapes easy definition, one may attempt to provide a general outline of a leading research thesis. Thus, in accordance with the above reservations, the following working thesis can be formulated: an information society, along with its institutions, gen-

erates serious problems that may significantly affect the progress of responsible development, both in terms of social awareness and support for the idea and in the context of modern economic practice. In other words, an information society represents more of an impediment than a facilitator for the effective propagation and implementation of the idea of responsible development.

The research focused on the identification of main barriers related to an information society and knowledge-based economy in the context of responsible development. The identification based on critical analysis of literature (information sources) and used desktop research methods. In this goal used half thousand Polish and English articles and books, conference pronouncements, which concentrated on similar problems. They were economical, sociological and human communication studies. Based on the several criteria, the authors displayed eight important barriers related to an information society and knowledge-based economy in the context of responsible development (Poskrobko, 2009a):

- barriers of interpersonal and social communications,
- exclusion from information,
- information asymmetry,
- information noise,
- difficult to verify the level of information truth,
- reduced reliability of information sources,
- insufficient wisdom,
- inadequate natural intellectual capacities of the human mind.

The main goal of the research has a form: what is the importance above mentioned kinds of barriers in literature and consciousness of researchers (what is a percentage level?)?

Disputes over the notions of development and responsible development

Since the 19th century, the concept of socio-economic development has raised numerous controversies and disputes. Representatives of classical economics – Adam Smith, David Ricardo, Thomas Malthus, or John S. Mill – aspired to shed some light upon mechanisms of this process and formulate their own concepts of development. Their early attempts have since inspired many movements, most notably – the idea of secular stagnation (Jabłońska, 1988). For Karl Marx, mechanisms of socio-economic formation were a potential source of important information on future developments of human civilisation (a prognostic aspect of the theory of development).

In time, the increased attention placed upon social aspects of the various theories of development have led, on the one hand, to gradual limitation of economic aspects (which were the central focus of the subjective-marginalistic school of economic development and, on the other hand, to identification of discretional stages of development based on various factors, including non-economic ones (a trend well represented by the Historical School or Veblen's and Schumpeter's institutionalism) (Schumpeter, 1996).

The above trends were employed in modern economics in the form of a theory of economic growth, with models construed on the basis of formal mathematical expressions. This particular approach to development proved quite potent and held dominion over modern economic publications, academic handbooks, scientific monographs, and even some of the most important works of numerous laureates of the Nobel Prize in economic sciences (Krelle, 1985). For many years, any alternative approaches to the subject were shunned as nothing more than intellectual curiosities.

The situation changed drastically in the second half of the 20th century, in response to new challenges of economic practice. By then, it became apparent that the available theories and models of economic growth would be inadequate for the identification of such new phenomena, and thus impractical in providing viable solutions. The most dramatic display of this shift was evident in the first two editions of the Club of Rome report (Meadows et al., 1972; Mesarowić, Pestel, 1977), with their emphasis on devising a new concept to socio-economic development to integrate the changed reality of economic practice with methodological and cognitive fundaments of the holistic approach in its broadest (global) perspective (Czaja et al., 1993). These ideas were aptly reflected in later approaches, such as the idea of sustainable development originated in the 1970s and 80s (Nasza..., 1991).

Soon after the environmental aspects of global civilizational transformations became apparent, other symptoms came into play, most specifically those related to the ongoing information and IT revolution and the emergence of an information society. The latter came complete with its own set of economic activities, collectively referred to as knowledge-based economy. The scope of changes has brought radically new dimensions to processes of socio-economic development by introducing a number of new phenomena and factors defining directions of the present transformation of the modern world.

Such variety of concepts of development has invariably led to confusion and problems, particularly with regard to their persuasive power and social acceptance, adding a considerable load to the already potent set of challenges associated with their formulation and implementation. Good evidence of this trend is the idea of sustainable development: after the initial wave of fairly

enthusiastic opinions (Rio de Janeiro, 1992), the concept soon faced a number of practical challenges, which strongly affected the pace of implementation while giving rise to more and more criticism. Consequently, new concepts were developed (such as the Millenium Development Goals of 2000), but they also seemed to lack proper economic support or perseverance in their effective implementation. At present, there are more than a dozen large strategies based on such ideas of socio-economic development, but it is difficult to provide an example of a successful implementation of this type (even if we take into account partial or limited implementations). One of the relatively positive examples is the strategy of the European Union (Towards Sustainable Development 2030), which has been implemented with some success, at least in the countries of so-called Old Europe.

Even less numerous are examples of strategies characterised by good adjustment with the modern challenges of an information society, knowledge-based economy, and information as a dominant factor of socio-economic development. Disputes arise not only with regard to the practical operation of information society and knowledge-based economy but also to proper use of the available data/information resources in socio-economic development processes. These have resulted in the formulation of the most recent concepts of socio-economic development, such as responsible development and wisdom-based economy. To what extent these new concepts relate to the most important problems associated with the practical operation of an information society?

Selected problems associated with the practical operation of an information society

Information society and the associated concept of knowledge-based economy represent not only civilizational progress but also a broad array of new problems and barriers to such development. This section of the paper presents selected problems representative of this type of impact. As it seems unfeasible to aspire to present a complete identification and diagnosis for all such problems, these study places focus on some of the most significant challenges, as seen from the viewpoint of responsible development (figure 1).

Information overload coupled with information noise represents the most difficult challenge from the viewpoint of information society and knowledge-based economy, as a source of problems related to the identification of usable information and elimination of irrelevant data from lists of criteria employed for decision-making purposes (Becla, 2018). Those factors are also responsible for difficulties in information gathering and processing, such as
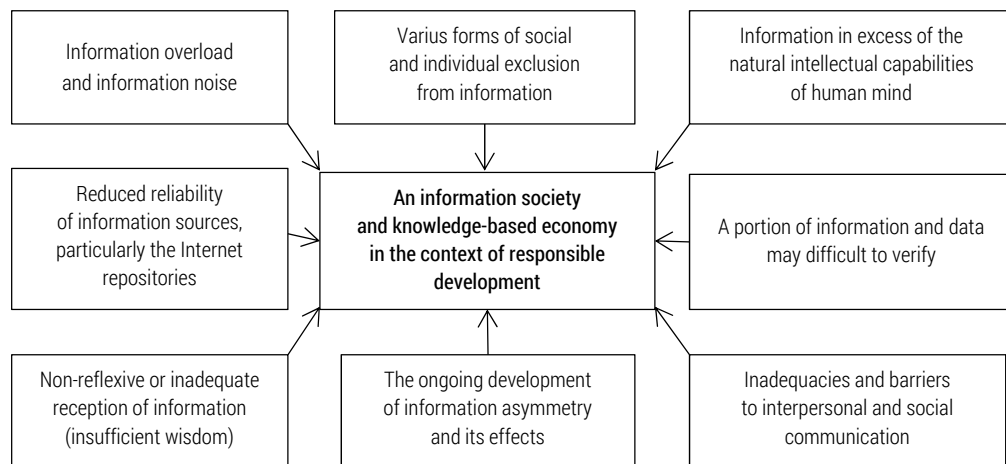
Figure 1. Selected challenges and barriers related to an information society and knowledge-
         based economy
Source: author's work.

long processing times and the associated cost increase, particularly the transaction cost and the alternative cost of information acquisition (Becla, 2019). These challenges also contribute to the limitation of knowledge creation processes, both in individual perspective and with respect to internal knowledge held collectively by social groups. Lastly, information overload results in the devaluation of real and usable information, as its value is much affected by the excessive load of the accompanying 'trash value' information (Cieślarczyk, 2016).

The accelerated development of information society and knowledge-based economy is clearly accompanied by various forms of information-related exclusion, on the level of both individuals and whole social groups (Becla, Czaja, 2010). Such exclusion may be manifested in subjective or objective form. The former type relates information exclusion to such factors as intellectual limitations, inadequate competences or cultural barriers. The latter type, in contrast, represents a result of conscious choices made by individuals or members of social groups. Irrespective of their origin and cause, every form of information exclusion clearly limits the participation of the affected individuals or groups in practical realisations of processes related to information and/or generation of knowledge (wisdom).

Progress of an information society does not necessarily correspond with the individual development of its members and their awareness of recommended civilizational transitions. Many individuals and quite a few social

groups display an inadequate level of intellectual skills required for information acquisition, processing and interpretation. This inadequacy is manifested not only in knowledge but, most of all, in wisdom (Zacher, 2012). The above observation gives rise to the following research hypothesis: a society abundant in information is more prone to display greater levels of intellectual inadequacy which limits their ability to select and utilise information. The above statement, however, needs further verification (Poskrobko, 2017).

Contrary to popular belief, education services provided as part of the broad framework of information society do not contribute to higher average levels of intellectual competence. This paradox is evidenced in such recent phenomena as: (1) gradual but steady simplification of language employed in interpersonal and social communication, (2) rapid progress of functional illiteracy in developed societies, (3) alarming decline of general knowledge in mathematics, natural sciences and technical science, coupled with a radical increase in the use of mechanical and electronic devices, (4) 'pictographic' reception of information and difficulties in interpreting messages presented in the alphanumerical form (texts). In addition, the value of genuine scientific knowledge is also in rapid decline, as valuable information is often buried under layers and layers of 'trash' information, needlessly redundant data and false or even manipulated and deceptive information (Poskrobko, 2011b).

Communication inadequacies and barriers to interpersonal and social communication represent another spacious category of problems related to the development of an information society. These may take on a variety of forms, including information ineffectiveness (in the context of both products and processes), the imperfection of direct communication processes, general barriers to interpersonal communication, or limitations of verbal or non-verbal elements of communication (Becla, 2018). Modern technical and technological solutions do not seem to contribute to the effective limitation of communication imperfections. On the contrary, they only add to the load by promoting such negative effects as a further simplification of communication messages, lack of respect for spoken word and unrestrained use of highly ambiguous pictorial lingo. In modern interpersonal communication, pictures and emoticons are used in place of words, and raw emotions are placed before reason (Fehler, 2016).

In addition, the setting of an information society seems to promote low reflexivity among recipients of information, which ultimately leads to deterioration (inadequacy) of wisdom. This includes not only lack of proper and rational use of the available information and knowledge, but also application of information and knowledge for immoral or criminal purpose or mindless use of information/knowledge with no regard for potential effects of our actions. Taking responsibility – be it social, legal or intellectual – for our spo-

ken words and their effects seems to be a thing of the past, and has ostensibly been replaced by a sense of impunity or at least general latitude in this respect.

The context of information society and knowledge-based economy is also a favourable setting for rapid development of information asymmetry and proliferation of its various effects, from abuse of information advantage, through the adverse selection and moral hazard, up to ideological manipulation (Becla, 2018). Economic, social and political consequences of these and related phenomena have already been subject to extensive studies (Potencjały, 2018) stimulating vivid interest in the scientific community and gaining formal recognition, including one Nobel Prize in Economic Sciences[1] (Pala, 2016).

Another important challenge in the development of an information society and knowledge-based economy is the problem of declining reliability of information sources and the associated difficulties in determining reliability and veracity of specific information or data. In general, IT and information systems store four types of information (as seen from the viewpoint of data reliability), namely: (1) true and reliable information founded on scientific knowledge and confirmed using various methods of verification (falsification) – the scientific knowledge, (2) true information construed by individuals on the basis of empirical evidence – practical knowledge, (3) false information provided without verification, but not intended to deceive – such as gossip or hearsay, and (4) false information prepared with the intention of deceiving or manipulating their recipients. All four types of information are often published side by side in joint online repositories, with no regard for their factual content, generating steep barriers to access true information, both in terms of expertise needed for the task and the steep cost associated with evaluation of their true value (veracity, accuracy, etc.) (Kiszka, 2016).

The authors of analysed information sources were conscious of these eight kinds of barriers and their importance in the information society and knowledge-based economy (on the average over 50% sources). Next precision researches are necessary. In another situation, the implementation of responsible development will threated. The threat symptoms are existing now.

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[1]   G. Akerlof, A. Spence and J. Stiglitz jointly received the Nobel Memorial Prize as early as in 2001, in recognition of their analyses of information asymmetry and information economics.

Table 1. The results of desktop research

Kind of barriers	Numbers of analysed information sources	Percentage information sources, where kind of barrier was noticed
1.Barriers of interpersonal and social communications	325	68%
2. Exclusion from information	120	70%
3. Information asymmetry	200	75%
4. Information noise	290	60%
5. Difficult to verify the level of information truth	110	50%
6. Reduced reliability of information sources	150	70%
7. Insufficient wisdom	85	60%
8. Inadequate natural intellectual capacities of the human mind	90	50%

Source: author's work.

The above challenges and barriers in the development of an information society result in aggravation of the following phenomena (*Nasza…*, 2018):

- the rise of *wrongly-informed man* and *bad-informed man*,
- the growing predisposition of certain groups and individuals to be steered by ideological manipulation,
- the growing number of individuals and groups excluded from information processes (information exclusion),
- the rise of an *informationally-confused man*, and
- the growing number of people with less than adequate knowledge, including those deemed 'utterly stupid'.

Such conditions are prone to generate unique problems and challenges with regard to propagation and implementation of such a specific knowledge-based concept as the idea of responsible socio-economic development. Which elements of the process should be emphasised in order to ensure effective dissemination of the idea of responsible development in the changed context of information society and knowledge-based economy, or more specifically, in the context of the wisdom-based economy? (Skinner, 2018; Tegmark, 2019).

Responsible development and dilemmas
of an information society

Responsible development should be founded on several base elements, namely (cf. figure 2):
- proper understanding and correct operationalisation of the idea,
- propagation of awareness of the associated strategies of development among individuals and groups and in varied contexts (from local to global),
- acceptance for objectives and principles of responsible development both in relation to a worldview (shared values) and in practical applications (habits and customary behaviours),
- provision of scientific fundaments for the selected strategy of development (knowledge) complete with proper axiological and emotional use of such knowledge,
- provision of suitable economic resources (in terms of quality and quantity), including human, material, energy and information resources (*Ekonomia…*, 2011a).
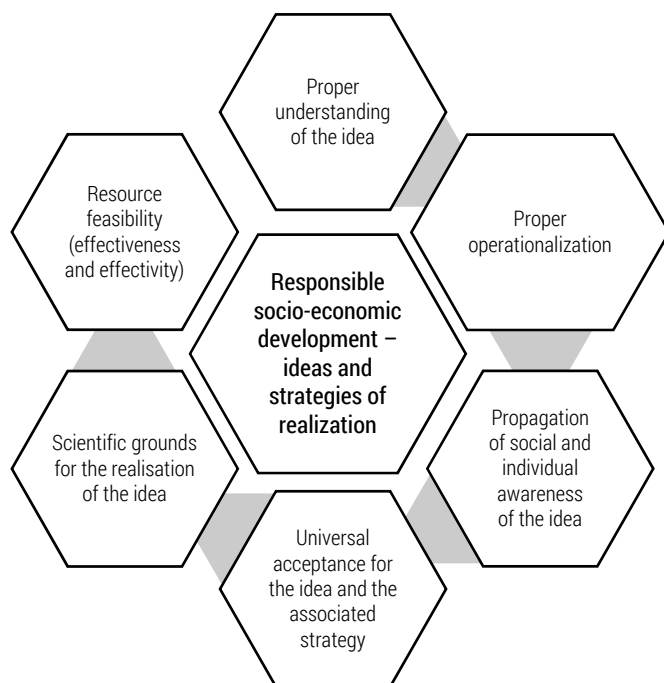

Figure 2. Fundaments of responsible development
Source: author's work.

In the light of the above requirements, strategies of responsible development can only be implemented under conditions of well-established information society and suitable economy, one based not only on knowledge but also (or most of all) on wisdom. This conclusion emphasises the need for competent individuals and social groups able to operate efficiently under conditions of information overload, equipped with skills needed for effective filtering of information in any available forms. At the same time, individuals should display adequate emotional maturity (emotional wisdom) to ensure their awareness of information significance and potential consequences of its use. They should be ready and willing to overcome inadequacies and barriers to interpersonal and social communication. As information creators, they should take proper care to ensure that information generated by them is reliable and verifiable. They should be able to avoid the effects of information asymmetry with due consideration for the good (i.e. interests and expectations) of other individuals or groups, which can only be obtained through the limitation of competition for rare economic resources and through the natural limitation of effects of responsible development. Such a mindset typically takes the form of more or less radical abstinence from patterns of excessive exploitation and consumption. As such, it presents a model of 'a new cyberman' which, for the moment, seems to escape easy categorization.

The available analyses of an information society and knowledge-based economy are clearly dominated by the assumption that individuals and social groups are suitably equipped to deal with new civilizational conditions and that they are able to predict and project the desired consequences of new phenomena or other determinants. As evidenced in the protracted realisation of the idea of sustainable development, the early fascination with a new concept soon gives way to controversies in interpretation, with the additional load of practical problems and obstacles to strategy implementation. In general, the more complex and ambitious is a general idea, the more pronounced are the associated challenges, and the less identifiable are the goals and objectives. This statement holds true for any type of development concept, including the ideas of sustained and durable development, integrated development or, as the case may be, responsible socio-economic development.

Empirical studies in this area are fairly scarce, but provide a much more critical evaluation are based on more solid grounds, as opposed to theoretical research founded on a priori models. In effect, they provide a more accurate picture of those imperfections and challenges associated with an information society and knowledge-based economy which may hamper or even prevent the effective realisation of strategies of responsible socio-economic development and creation of wisdom-based economy. Contrary to popular beliefs, participants of information societies and global communication net-

works are not necessarily well-informed as a whole and not that much resistant to ideological manipulation. The recent development of stupidology (the study of human stupidity) as a genuine discipline of science over the last few decades can be seen as evidence for the validity of these unsettling observations.

Conclusions

We have to research the problem of barriers related to an information society and knowledge-based economy in the context of responsible development. The researches should have empirical and theoretical nature. This is the basic condition of implementation of responsible development strategy, on the micro (single persons and household) and macro (society and economy) level (Piergud, 2016). The responsible development policy must to limitation above mentioned barriers. This is second conditions of effectiveness implementation responsible development strategy. Above mentioned barriers are one of the biggest dilemmas of information society and knowledge-based economy. They are the challenges of human civilization future.

The researchers have a consciousness above mentioned barriers. But they interest in this problem sufficiently rarely. Majority difficulties implementation process of the responsible development strategy have reasons in existing barriers, in this area.

Information society and knowledge-based economy represent an interesting direction in the development of human civilization. However, to effectively cater for the needs of the nearly 8 billion members of the human population, it is essential to correctly identify the associated dilemmas (as well as barriers and imperfections) which will then be used in design and implementation of suitable corrective measures. If the future of human civilization in each of its dimensions (from individual to global) is to progress in man's best interest and expectations, it must be founded on suitable forms and principles of an information society, information-competent individuals, and wisdom-based economy. If these postulates cannot be satisfied, the effective realization of responsible socio-economic development will not be possible. This conclusion alone makes them a promising area of study, and one deserving further scientific exploration.

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The contribution of the authors

Agnieszka Becla – 50% (conception, literature review, methodology, conclusions).

Stanisław Czaja – 50% (conception, literature review and discussion, methodology, conclusions).

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ENVIRONMENTAL POLICY AND MANAGEMENT

POLITYKA EKOLOGICZNA I ZARZĄDZANIE ŚRODOWISKIEM

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FRAMING EFFECT AND PUBLIC SUPPORT FOR THE ENVIRONMENTAL POLICY

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ABSTRACT: Framing effect consists in the fact that how a problem is presented (or framed) affects the decision maker's perception of the problem and their preferences. Public opinion about the environmental policy can vary depending on how the aims and consequences of particular policy actions or instruments are featured. The paper aims to exa-mine how alternative ways of framing SO_2 pollution problem (highlighting consequences for human health, nature and state finance) affect the public support for abatement policy (emission fees and emission trading) and bearing higher heating costs. The research made use of an experiment with students as participants. The results were analysed using the two-sample t-test. The findings suggest that highlighting the impact of environmentally damaging behaviour on human health may increase the public support for the imposition of environmental policy instruments and may encourage voluntary actions aimed to protect the environment.

KEY WORDS: behavioural economics, environmental policy, framing effect

Introduction

The mainstream environmental policy theory is based on the neoclassical economics assumption of *homo economicus* always acting with unbounded rationality and self-interested motives. This assumption can be found among others in Pigouvian negative externality analysis, Coasian property rights approach to pollution control, cost-benefit analysis of environmental changes, and common property resource management (Venkatachalam, 2008). However, individuals do not always react to environmental policy instruments as predicted by neoclassical economics. Human behaviour, determined by many psychological circumstances, often deviates from the *homo economicus* pattern. That is why some environmental economists move towards the theory of behavioural economics (including prospect theory, framing effects, decision biases, hyperbolic discounting) which offers more realistic views on human behaviour.

On the basis of behavioural economics foundations, R. Thaler and C. Sunstein developed the nudge theory. This theory assumes changing behaviour by modifying the choice architecture through the use of nudges (Cooper, 2017, p. 11). A nudge can be defined as a way of 'influencing choice without limiting the choice set or making alternatives appreciably more costly in terms of time, trouble, social sanctions, and so forth' (Hausman, Welch, 2010, p. 126).

The concept of using nudges in public policies has gained popularity among others in the UK and the US. The nudge can be seen as 'a substitute for more conventional coercive interventions such as command and control regulation' (Van der Heijden, Kosters, 2015, p. 4), so-called 'behaviourally informed interventions' (Olejniczak, Śliwowski, 2014, p. 24). An example of using nudges in public policies can be an appropriate framing, i.e. a congruent way of presenting the information.

The aim of the paper is to examine how alternative ways of framing (or presenting) sulphur dioxide (SO_2) pollution problem (highlighting consequences for human health, nature and state finance) affect the public support for abatement policy (emission fees and emission trading) and bearing higher heating costs. This study contributes to the discussion of behaviorally informed interventions in environmental policy as the human health and financial frames remain relatively under-researched. According to the best of the author's knowledge, framing SO_2 pollution issue taking into account impacts on human health, nature and state finance have not been considered in the literature before. The study provides new insights into framing the pollution problem in terms of economic consequences for state finance in an unexplored setting by investigating the public support for environmental

policy in one of the new European Union member states (i.e. Poland), in which the EU membership is an important political and social issue.

Behavioural aspects of environmental policy

Consequences of human biases resulting from bounded rationality and other psychological circumstances can be observed, among others, with regard to environmental policy. As for Croson and Treich notice, the environment is often associated with strong moral feelings (guilt, shame, pride etc.), which may affect citizens' beliefs and attitudes toward green consumption, policies and politics. Moreover, many environmental issues are complex and have the nature of public goods. They also often have long term and global effects, increasing the scope for bounded rationality (Croson, Treich, 2014, p. 336).

Environmental policy, as other areas of public policy, has to face different risks. According to some experimental research, people tend to systematically misjudge the expected impact of low probability, high-severity events such as catastrophic climate change, biodiversity loss, pest/disease invasion or nuclear disaster. These misperceptions can lead to inefficient levels of insurance and risk prevention, as well as incorrect economic valuations of environmental risks (Shogren, 2012, p. 5). The perception of risk by the public may be very different from that of experts, contrary to what is assumed in the neoclassical theory. An example of the risk perception bias in air pollution is the observed overestimation of risks associated with outdoor air pollution compared to those associated with indoor air pollution (Carlsson, Johansson-Stenman, 2012, p. 87). The problem resulting from the misperception of risks is the choice of the risk perception on which to base environmental policy: on the perception of risk by the public, by experts, or on other criteria (Carlsson, Johansson-Stenman, 2012, p. 88).

Crowding out effects are another behavioural aspect of environmental policy, neglected in the neoclassical environmental economics. They consist in the fact that financial incentives affect moral obligations to behave pro-environmentally. People can be deprived of the feeling of having done something good and thus can become less motivated intrinsically to behave in this way if altruistic actions are monetarily rewarded. What is more, compensating the effects of their behaviour can make them believe that they have a right to deviate from pro-environmental behaviour, in other words, that they have the right to pollute (Garcia-Sierra et al., 2015, p. 295).

For most people, self-image and social approval are important. They care about how they perceive themselves and how others perceive them. In terms

of environmental issues, people usually want to see themselves and be seen as responsible citizens. As Carlsson and Johansson-Stenman point out, 'the existing literature on ecolabeling and green consumerism, as well as that on fair trade, has often been framed within a classical market context in which price and quality are the drivers of consumer choice. However, consumers may also be concerned with the choices made by other consumers, and people's consumption decisions may therefore not be independent of social context' (Carlsson, Johansson-Stenman, 2012, p. 81).

The knowledge of behavioural patterns and biases of which examples are described above can be used in the environmental policy-making process, in the policy design and implementation (OECD, 2017). A key policy instrument in this context is 'green nudges' that make environmental behaviour of individuals be influenced by subtle modifications of their decision context. Among 'green nudges' aimed at promoting environmentally responsible behaviour, there are those:

- capitalizing on consumers' desire to maintain an attractive self-image through 'green' behaviour, by either simplifying product information or by making certain product characteristics more salient,
- exploiting people's inclination to 'follow the herd', i.e. to imitate the behaviour of their peers; e.g., by conveying certain social norms through peer comparison,
- exploiting the behavioural effects of purposefully set defaults that stipulate what happens if people don't actively choose (Schubert, 2017, p. 329-331).

Thus, the behaviourally informed interventions of the policymakers to tackle environmentally damaging behaviour include, among others, simplification of complex environmental information aiming to prevent information overload, framing of information in order to arouse desirable attitudes of individuals, changes to the default policy, changes to the physical environment, use of social norms, comparisons and timely feedback mechanisms. The practical examples of 'green nudges' can be:

- framing of energy efficiency labels aiming to focus on the savings that individuals could gain when choosing the best-in-class electric appliance in terms of energy efficiency,
- the proper location and colour of recycling bins,
- sensor-based water taps,
- messages on the water bill comparing the household's consumption with the average household in the same neighbourhood,
- placing stickers emphasising the need to save water next to faucets,
- the default setting of thermostats at a lower temperature,

- real-time feedback on energy consumption through in-home displays (OECD, 2017, p. 4-5 and 8).

According to the OECD report (2017, p. 7) the majority of interventions are based on simplification and framing of information.

Framing effect as a cognitive bias in the environmental setting

When the same problem is framed in different ways, the psychological principles governing the perception of decision problems and the evaluation of probabilities and outcomes produce predictable shifts of individual's preference (Tversky, Kahneman, 1981, p. 453). Framing effect occurs when presenting information in different modes changes how people make judgments and decisions about equivalent choice problems. The literature suggests that the framing effect is critical to our understanding of how people make decisions, and especially choices involving risk (Carpenter, 2018).

Tversky and Kahneman have identified three particular types of framing that can result in actions that are anomalous by:
- framing of acts, referring to the question of whether two decisions are presented independently or in tandem,
- framing of contingencies, referring to whether a possibility is presented as more or less contingent or certain, and
- framing of outcomes referring to whether outcomes are presented as gains or losses in respect of the status quo (Nash, 2006 p. 318).

Framing effects with regard to environmental problems or policy are among the topics more and more often undertaken in the literature on behavioural, environmental economics. This is the case especially for climate change consequences and mitigation policy. Some studies presented below investigate how different framing impacts public opinion on environmental problems and policy actions.

The results of research on the effect of the message frame on attitudes towards sustainability and energy consumption in Belgium indicate that to promote and strengthen pro-environmental behaviour it is necessary to emphasize possibilities of overcoming environmental problems rather than the gravity of these problems. This case is similar to the so-called "Asian disease problem". Additionally, according to the research findings, the framing effect depends on age, gender, education level, and pro-environmental attitude (Van de Velde et al., 2010).

Severson and Coleman (2015) assessed the effects of various frames (moral, scientific, and economic) on support for climate change mitigation policies. The religious, moral frame emphasized the stewardship of humans

over God's creation, whereas the secular one accentuated widely shared values such as a duty to one another or concern for future generations. The economic frame took two forms: an equity frame and an efficiency frame. The former emphasized the uneven distributional effects of climate change among poor island countries and the latter referred to the costs and benefits to the United States of taking action on climate change. The negative science frame highlighted the negative consequences of inaction in the face of climate change, and the positive science frame underlined the positive consequences of climate change mitigation action. The research results are mixed. The positive and negative scientific frames, the secular moral frame, and the economic equity frame had the potential to increase public support for climate change mitigation policies, whereas the religious, moral frame and the economic efficiency frame were ineffective at enhancing this support.

The influence of framing climate change in terms of perceived scientific consensus about its environmental consequences was also investigated by van der Linden et al. (2015). Using pre and post measures from a national message test experiment in the US, they found that increasing public perceptions of the scientific consensus was significantly and causally associated with an increase in the belief that climate change is happening, human-caused and a critical threat. In another study (van der Linden et al., 2014) they present results of the research aimed at testing the efficacy of different ways to communicate the consensus-message (a descriptive text, a pie chart, and metaphorical representations) on climate change. According to their findings a visual form, i.e. a pie chart is the most effective in conveying the message about the scientific consensus due to its simplicity, shortness, and easiness to comprehend and remember.

In an experimental approach, Cason and Raymond (2011) used environmental framing as a treatment variable in the context of an emissions trading system with voluntary reporting of emissions and imperfect enforcement in order to investigate whether environmental framing influences behaviour towards pollution control and reporting. The imperfect enforcement was modelled as random inspections to determine whether pollution reports were accurate, with monetary fines imposed for under-reporting. In environmental framing, the item being traded was described as an emissions permit, and experiment participants were required to report pollution of greenhouse gas emissions at the end of each period, whereas in neutral framing participants traded "coupons" and reported a "number". The research result suggests that environmental framing reduced subjects' incentives to honestly report pollution to the experimental regulator due to the negative connotation of being a larger polluter. These results persist even when controlling for participants' self-reported attitudes toward the environment and climate

change, motivations for compliance with rules and demographic characteristics.

In a framed laboratory experiment on downstream water pollution, Czap et al. (2013) investigated the importance of empathy vs self-interest framing in determining the behaviour of upstreamers (i.e. persons who live upstream) regarding the negative externalities, and the potential of downstreamers (i.e. persons who live downstream) to influence the choices of upstreamers using non-monetary sanctions and rewards, alleviating the need for intervention by the local governments and regulatory institutions. Their findings provide evidence that environmental policy should appeal to the empathy of polluters and promote social punishment and public shaming as strategies to achieve lawful or cooperative behaviour. Empathy framing had a much more significant impact on individual behaviour than self-interest framing. Overall, individuals' behaviour was more profit-oriented in the self-interest framing and more egalitarian in the empathy framing.

Singh and Swanson (2017) examined the influence of three frames on the importance that individuals assign to climate change policy. These frames included putative national security, human rights, and environmental consequences of climate change. They did not find that framing climate change altered the perception of its importance as a policy issue among the overall public. However, they observed that the assigned importance of climate change policy varied depending on political views. Republicans and the rightists sometimes assigned less importance to climate change policy when the issue was framed in terms of national security and climate change, while Democrats and the leftists, perceived climate change as more important in the case of national security and human rights frames. These patterns held the strongest when the frames were presented with accompanying official sources of information.

Individuals' preference for environmental policy may be influenced by news framed as either emphasizing harmony with nature or mastery over nature. The results of research on the interplay of ecological worldviews and media frames by Fung, Brossard, and Ng (2011) suggest that harmony frame amplified the effect of the balance-with-nature worldview in supporting a natural approach to flood protection. In contrast, the mastery frame amplified the effect of the human-domination-over-nature worldview on the preference for a structural approach to flood protection. The natural approach relied primarily on land management and suggests the relocation of businesses and houses, to restrict development on flood-susceptible lands, and to carve out more overflow areas for floodwaters. The structural approach suggested building stronger and more technologically advanced dams and levees in flood-prone areas.

Mossler et al. (2017) measured support for carbon emissions mitigation policies from individuals presented with one of five different policy frames (climate change, global warming, carbon pollution, air pollution, and ocean acidification). The "air pollution" frame generated the highest degree of policy support overall, while the „ocean acidification" frame elicited the least support overall. The "carbon pollution" frame won a little more approval for mitigation policies than "climate change" or "global warming" frames. Framing effects were partially contingent on prior knowledge and attitudes and mediated by concern.

Similar research has been conducted by Schuldt et al. (2011) who in a question wording experiment found that framing problems with rising temperatures as "global warming" rather than "climate change" made Republican respondents more sceptical that global climate change is a real phenomenon, whereas other political groups were unaffected by question-wording.

A comparison of local versus global framing of climate change in terms of individuals' perception of this environmental problem's severity, willingness to support policy actions and to take voluntary actions to mitigate climate change are also the topics of some studies. However, these studies present contradictory findings. According to Wiest et al. (2015), local framing is more effective in enhancing perceptions of the severity of climate change, support for sub-national policy action and some behavioural intentions to address climate change. Additionally, presenting information on the potential benefits (e.g. longer growing seasons) and losses of climate change weakens perceptions of the problem's severity at the local and national level as compared to information on the potential losses only. Wiest et al. point out that the effectiveness of particular frames of climate change impact depends to some degree on individual political leanings. Similar inferences were drawn by Scannell and Gifford (2013) who in their study, investigated how spatial distance influenced climate change engagement. In their experiment participants completed questionnaires concerning attitudes to climate change after having read messages on local or global climate change impacts. They found that local message frames appear to improve communication of negative climate impacts. On the other hand, the findings of the experiment by Spence and Pidgeon (2010) indicate that framing climate change impacts as distant ones results in perceiving them as more severe in comparison to local ones. Moreover, according to their research results, attitudes towards climate change mitigation were positive when individuals were asked to consider social rather than personal aspects of climate change (i.e. benefits and risks arising from climate change in terms of personal considerations only were assumed to relate to local climate change impacts).

In general, the above-presented studies suggest that framing an environmental problem in a certain way may have more potential than others to make individuals assign this problem greater importance, to increase public support for mitigation policy and to strengthen pro-environmental behaviour.

Research methods

The experiment was conducted during two academic years: 2017/2018 and 2018/2019 and a total of 288 students from AGH University of Science and Technology took part in it. Participants were randomly given one of three short descriptions of the consequences of excessive sulphur dioxide emission, presented in different frames referring to human health, nature (forests) and financial penalties (cf. table 1). Each treatment group numbered 96 persons concomitantly. The random assignment of the participants to treatment groups is a prerequisite for the experimental research. The data on socio-demographic features of the participants were not collected.

Table 1. Information frames for SO_2 emission effects

Frame	Content
Human health	Sulphur dioxide belongs to the most important air pollutants, and it is emitted mainly when fuels containing sulphur are burned. It causes severe health problems including cardiovascular diseases (e.g. narrowing of the arteries, heart attack), breathing problems, irritation of eyes, nose and throat, headache and anxiety. It contributes to the smog formation. According to different sources, about 20-67 thousand people die in Poland annually due to the smog.
Nature	Sulphur dioxide (SO_2) is very harmful to all living organisms, particularly to plants. In the air SO_2 oxidises to SO_3 and in combination with water forms sulphuric acid that is the main cause of acid rains. SO_2 may cause contamination of vast natural areas due to shifting around over long distance. It negatively impacts forests, causing soil acidification, dysfunction in the edaphic solution and changes in the availability of alimentary components. SO_2 emission and acid aggradation have been a significant problem in forest areas worldwide for several decades, leading to an overall reduction in the increment of trees, i.e. decrease of the thickness of growth rings and tree height and morphologic damage of needles and leaves.

Frame	Content
Financial	Within the struggle for abatement of excessive sulphur dioxide emission, the adoption of new European Union regulation is planned imposing penalties for member states for noncompliance with incoming tightened standards of concentration of this gas in the air. In the case of non-compliance with the new standards and taking into account the current level of sulphur dioxide emission in Poland, the estimated amount of financial penalties that Poland would pay totals about 3-4 billion PLN annually. EU member states have time to conform to the new regulation until the end of 2021.

Source: author's work. The information on health impacts was developed on the basis of the report of the European Environment Agency (EEA, 2013) and the effects on nature were described using the work by Baciak et al., 2015. The financial frame is the author's description.

Participants of the experiment were then asked to assess their support for two instruments proposed as a solution for excessive SO_2 emission: the imposition of additional emission fees and launching of the cap-and-trade program and to assess their support for (voluntarily) bearing higher heating costs due to the use of the least sulphur-containing fuel. They could express their opinion using a 7-point Likert scale (cf. table 2). In the analysis the answers were given the value from 1 to 7, starting from the strongly negative attitude ('I strongly disapprove') to the strongly positive one ('I strongly approve').

Table 2.   Solutions for SO_2 emission abatement problem proposed to experiment participants

Description of proposed instruments within the environmental policy	Questions	Possible answers
Proposed solutions of SO_2 emission abatement include the imposition of additional emission fees of 2,7 PLN/kg and/or implementation of the obligatory SO_2 cap-and-trade program for heavy polluters (mainly power plants). This latter solution consists in the allocation of allowances for SO_2 emission among polluters and the possibility of buying/selling allowances between interested parties. The enterprise participating in the cap-and-trade program has to cover its SO_2 emission with allowances granted or bought on the market.	• Do you approve of the imposition of additional SO_2 emission fees for heavy polluters? • Do you approve of the launching of the SO_2 cap-and-trade program for heavy polluters? • Do you approve of (voluntarily) bearing higher heating costs due to the use of the least sulphur-containing fuel?	• I strongly disapprove • I disapprove • I rather disapprove • I do not have an opinion • I rather approve • I approve • I strongly approve

Source: author's work.

The differences in the support for environmental actions between three groups of participants were analysed by means of the two-sample t-test, in which (Wieczorkowska, Wierzbiński, 2007, p. 180):
- the null hypothesis is that the means of two populations are equal: H_0 : $\mu_{1=}\mu_2$,
- the alternative hypothesis assumes that the means are not equal: H_1: $\mu_{1\neq}\mu_2$,
- the t-statistic is the following:

$$t = \frac{M_1 - M_2}{\sqrt{\frac{s_1^2 + s_2^2}{n}}} \tag{1}$$

where:
M – the mean in the sample,
s – the standard deviation in the sample,
n – the strength of each sample.

Research results and discussion

The support for proposed instruments and voluntary action within the SO_2 emission abatement policy among the experiment participants is presented in table 3. Regardless of the treatment group, the participants back the least bearing higher heating costs due to the use of the least sulphur-containing fuel, which is quite understandable. In the case of nature and financial frame, the imposition of the cap-and-trade program commands the highest endorsement, and in the case of human health frame, most support is won by the imposition of emission fees. All three proposed solutions for excessive SO_2 emission are approved the most by the participants from the group with human health frame. The participants from nature frame back more on average the cap-and-trade program and voluntarily bearing higher heating costs than those from financial frame. The opposite happens in the case of emission fees. The average total support for two instruments and voluntary action is the highest among the participants provided with information in the human health frame (5.20), then among the participants provided with information in the nature frame (4.54) and in the financial frame (4.50).

The diversification of the participants' attitudes toward the imposition of emission fees and voluntarily bearing higher heating costs in all three treatment groups is moderate. The coefficient of variation, i.e. the ratio of the standard deviation to the mean for emission fees equals 27%, 30% and 32% in the case of human health, nature and financial frame respectively. This coefficient for bearing higher heating costs totals 28%, 30% and 42% in the

case of human health, nature and financial frame respectively. The partici-
pants' attitudes toward the imposition of the cap-and-trade program are
slightly less diversified (the coefficient of variation is equal to 24%, 22% and
27% in the case of human health, nature and financial frame respectively).

Table 3. Support for proposed instruments and actions within the environmental policy

Instrument/action	Mean	Standard deviation
Human health frame		
Emission fees	5.53	1.51
Cap-and-trade program	5.41	1.28
Bearing higher heating costs due to the use of the least sulphur-containing fuel	4.68	1.31
Nature frame		
Emission fees	4.58	1.39
Cap-and-trade program	4.98	1.11
Bearing higher heating costs due to the use of the least sulphur-containing fuel	4.05	1.23
Financial frame		
Emission fees	4.70	1.51
Cap-and-trade program	4.90	1.33
Bearing higher heating costs due to the use of the least sulphur-containing fuel	3.91	1.63

Source: author's work.

Table 4. The two-sample t-test results

Frames	Emission fees		Cap-and-trade program		Bearing higher heating costs due to the use of the least sulphur-containing fuel	
	t-statistics	p-value	t-statistics	p-value	t-statistics	p-value
Human health vs nature	4.5353	0.0000	-2.4589	0.0148	-3.3915	0.0008
Financial vs nature	0.5434	0.5875	-0.4698	0.6390	-0.6973	0.4865
Financial vs human health	-3.7933	0.0002	-2.6992	0.0076	-3.5956	0.0004

Source: author's work.

Table 4 presents the two-sample t-test results. They reveal statistically significant differences in support for emission fees, cap-and-trade program and voluntarily bearing higher heating costs between human health and nature frames and between human health and financial frames at the significance level of 0.01 except for cap-and-trade program in human health and nature frame comparison (0.05). The attitudes toward proposed solutions in nature and financial frames do not differ in terms of statistical significance.

According to the findings of this study, framing the SO_2 pollution problem taking into account consequences for human health has more potential to increase the public support for proposed instruments and voluntary action within the SO_2 emission abatement policy than highlighting consequences for nature and state finance. These results are quite understandable, keeping in mind that health belongs to the most important values in life. The results of the survey carried out by the Central Statistical Office in Poland indicate that the health is of very great importance to 80.5% of the Poles and of great importance to 18.2% of them (GUS, 2017).

The nature frame has turned out to fail to increase the support for proposed solutions within the SO_2 emission abatement policy as compared to other competing frames. Similar results were indicated by Singh and Swanson (2017) who did not find the advantage of climate change framing in terms of environmental consequences of this change over other types of framing. Emphasizing the potential financial burden for the Polish state finance has proved to be not better than two other ways of presenting the SO_2 emission problem. This finding is in line with the above-cited research results by Severson and Coleman (2015) who examined, among others, the effect of the economic efficiency frame. Although the membership in the EU is important for the majority of the Poles and the financial penalties that could be imposed by the EU on Poland are quite often used in the public discussion as a bugbear, underlining this financial aspect in the context of the SO_2 emission abatement policy has not come out to be more effective than other frames.

The findings of the study do not suggest that highlighting pollution consequences for nature or state finance does not matter to the society but rather that there are better types of 'nudges' in the environmental policy that appeal to the personal aspects of environmental problems like the impacts on the human health. The similar interference can be drawn from studies by Scannell and Gifford (2013) and Wiest et al. (2015) who indicated that local framing of climate change (i.e. underlining consequences near to the people) was more convincing than global framing.

Conclusions

The behavioural, environmental economics combines the best of two disciplines: the normative power of traditional environmental economics together with a more realistic description of individual behaviour from psychology and other human and social sciences (Croson, Treich, 2014, p. 346). It should help to understand why people do not respond to environmental policy measures, as predicted by neoclassical economic theory and to improve environmental policy design (Pasche, 2013, p. 1).

The findings of this study support the assumption that psychological considerations may have a significant influence on people's attitude towards environmental policy. Individuals tend to support environmental policy instruments and voluntary action the most when the SO_2 pollution problem is framed in the context of consequences for human health. These inferences are rather not surprising, taking into account the fact that health is among the life aspects most prized by people.

The results of our study allow us to draw a conclusion that highlighting the impact of environmentally damaging behaviour on people's health by the regulators and other organizations involved in the environmental protection may increase the public support for the imposition of environmental policy instruments and may encourage voluntary actions aimed to protect the environment.

The study is not free from limitations regarding especially the sample that is confined to the students of one university. It could be extended by including other groups in terms of age, educational background and profession, e.g. managing directors in companies exerting a significantly negative impact on the environment and being subject to the environmental regulation. The research relates to the assessment of support only for emission fees, emission trading, and bearing higher heating costs in the context of SO_2 excessive emission problem under three specific framings. Other environmental problems such as climate change and other instruments of environmental policy could also be investigated regarding the perception and support for these instruments among different stakeholders taking into account a variant framing.

In the author's opinion, the behavioural aspects of environmental policy are interesting topics and require further investigation. They could provide additional insights into how psychological considerations influence different decision-makers regarding their environmentally damaging or desirable behaviours and help the regulators to design more effective environmental policy.

Acknowledgements

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CONVERSION OF AGRICULTURAL LAND INTO NON-AGRICULTURAL LAND IN POLAND

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ABSTRACT: The main aim of the work is to present legal procedures related to the transformation of agricultural land into non-agricultural land in Poland. Based on the analysis of selected legal regulations, activities and steps to be taken to start non-agricultural land use have been described. Both stages related to the transformation, i.e. change of land use and exclusion of land from agricultural production, have been extensively discussed. Interpretation of selected legal regulations made it possible to organize information on the procedure for transforming agricultural land into non-agricultural purposes. Moreover, on the basis of selected statistical data, the legal aspect has been supplemented with information on the current level of conversion of agricultural land in Poland.

KEY WORDS: agricultural land, change, destination

Introduction

It is not easy to analyze the legal aspects of the conversion of agricultural land into non-agricultural land. This is due to the continuity of changes that have occurred over the last few years in Polish law, which takes into account the change in the destination of real estate. Not without significance is also the issue of implementation of these new provisions of law by the authorities applying them, which can be problematic, especially when taking into account the undoubted need to interpret the changing regulations. They are often subject to uneven interpretation, which may have (also negative) impact on the legal situation of an entity which is the owner of real estate intended for construction purposes because as we know *scire leges non hoc est verba earum tenere, sed vim ac potentatem.*

It is important to note that rational agricultural land management is a key issue in the context of the principle of sustainable development, which has been given the status of a fundamental right in Poland. In accordance with Article 5 of the Polish Constitution: "The Republic of Poland shall safeguard the independence and integrity of its territory and ensure the freedoms and rights of persons and citizens, the security of the citizens, safeguard the national heritage and shall ensure the protection of the natural environment pursuant to the principles of sustainable development" (https://www.sejm.gov.pl; https://www.gov.pl/web/rozwoj/zrownowazony-rozwoj). The definition of sustainable development is regulated by the Environmental Protection Law. In accordance with Article 2 point 50 sustainable development is such a socio-economic development in which political, social and economic activities are integrated to protect the environment and secure the opportunity to meet the basic needs of present and future generations. It should be emphasized that land use significantly affects social and economic development as well as the quality of life of people. Planning the structure of land use in Poland is faced with a number of challenges, the main ones include the development of suburban areas, which is associated with an increase in demand for new infrastructure and functions that often cause conflicts with existing forms of land use; tendencies to distraction and depopulation in some rural communes or the small-area and fragmented individual agricultural farms (OECD, 2018).

It should also be noted that the indicators of the transformation of agricultural land in Poland are among the highest in Europe (Ustaoglu, Williams, 2017).

Therefore, the priority aim of this work is to present legal procedures related to the transformation of agricultural land into non-agricultural land in Poland. This study focuses on emphasizing the importance of the Act of 3

February 1995 on the Protection of Agricultural and Forestry Lands (Journal of Laws No. 16 item 78, as amended, with the latest amendment dated 26 May 2017, Journal of Laws 2017 item 1161) concerning the possibility of transforming land and agricultural real estate for non-agricultural purposes in Poland. The first part of the work presents the location of the process of transforming agricultural land for non-agricultural purposes in the general investment process. The procedures necessary for (colloquially speaking) "land reclamation" were also traced, including the change of land use for non-agricultural purposes, as well as the related exclusion of land from agricultural production. Moreover, legal aspects have been supplemented with statistical data illustrating the level of conversion of agricultural land in Poland.

Conversion of agricultural land into non-agricultural land as part of the investment process

As it is commonly known, an investor generally cannot independently (through an actual action) start using his land or agricultural real estate in a manner different from its intended use. It is not only illegal but also sanctioned by the state through restrictions of a financial nature, which will be discussed later in this article.

There is no doubt that an investor wishing to act by the law must undergo appropriate procedures (if required) before the commencement of non-agricultural land use. The proceedings related to the transformation of agricultural land for non-agricultural purposes consist basically of two stages, which are part of the broadly understood investment proceedings.

As already mentioned, the change of land use for non-agricultural purposes is, in most cases carried out in two stages. The first stage is the change of land use (within the local spatial development plan – in short also the LSDP or the relevant location decision), while the second stage is the exclusion of land from agricultural production.

The process of conversion of agricultural land into non-agricultural land is based on several legal acts such as Act of 3 February 1995 on the protection of agricultural and forestry land, Act of 27 March 2003 on spatial planning and development (Journal of Laws No. 80, item 717, as amended), Act of 14 June 1960 on the Code of Administrative Procedure (Journal of Laws No. 30, item 168, as amended), Regulation of the Minister of Infrastructure of 26 August 2003 on the method of determining the requirements for new development and land use in the absence of a local spatial development plan (Journal of Laws No. 164, item 1588) and Regulation of the Minister of Infrastruc-

ture of 26 August 2003 on the required scope of the local spatial development plan project (Journal of Laws No. 164, item 1587).

Only by taking into account all the above regulations will it be possible to effectively trace the process of transformation of agricultural land into non-agricultural land in Poland. It should also not be forgotten that the main objective of the above-mentioned regulations is to regulate land-use changes, i.e. to limit the determination of other than agricultural use of agricultural land (Strzelczyk, 2019, p. 126). Therefore, frequently decisions taken in the process of "de-agriculturalization" of soil have a negative character.

Agricultural land – a subject to conversion

As already mentioned, the 'de-agriculturalization' procedure is another way of converting agricultural land into non-agricultural land. It is a statutory rule (Article 6 of the Act on Protection of Agricultural and Forestry Lands) that land designated in the land register as wasteland should be used for non-agricultural purposes, and in case of lack of such land – another land of the lowest production utility.

Therefore, it seems crucial for the procedure of agricultural land transformation to define these lands for statutory purposes (Nowak, 2014, p. 19), and thus also related to the change of their destination. Particular doubts may arise in connection with the scope of the concept of agricultural land.

The type of land considered to be agricultural is located in article 2(1) of Act of 3 February 1995 on the protection of agricultural and forestry land.

It should be remembered that the real estate on which the construction of facilities classified as agricultural structures is planned does not lose its character of "agricultural land" or "agricultural use" (National Administrative Court (Supreme Administrative Court (NSA) decision in Warsaw, 2012, II OW 65/12). Also, the land occupied for access roads to agricultural land remains agricultural land, and if occupied for such a road, it is considered that in such a case it is not excluded from agricultural production (Regional Administrative Court (WSA) ruling in Łódź, 2018, II SA/Łd 140/18).

In conclusion, the concept of agricultural land itself is usually linked to the land register. A given land is an agricultural use where it is entered as such in the land register (Małysa, 2003, pp. 24-25). However, it should be noted that not only land entered in the land register as agricultural is considered as such by the legislator. A proper interpretation of this provision leads to the conclusion that also land which is not specified as agricultural land in the land register may be agricultural land within the meaning of the Act, such as ponds – Article 2, paragraph 1, point 11 of the Act on the protection of

agricultural land and forest land (Regional Administrative Court ruling in Kraków, 2010, II SA/Kr 816/10).

Land-use change – the first stage of transformation

The first step in converting agricultural land into non-agricultural land is to change its use. It is carried out at the municipal level under the so-called planning procedure. It consists in adopting (or changing) a local spatial development plan (in short: LSDP) within the planning authority of the commune, where private persons are allowed to participate in the procedure if they own (or intend to buy) land properties in the area covered by the plan.

The key element to be discussed is precisely this "change of land use". Therefore, within the planning authority, the commune authorities may change the designation of any area, taking into account both the interests of the owner protected by the Constitution (Tomaszewska, 2017, p. 35) and the provisions of the study of conditions and directions of the spatial development of the commune. Establishing the plan cannot lead to modification of directions and indicators of spatial development or exclude such development (Regional Administrative Court ruling in Wrocław, 2013, II SA/Wr 886/12).

It should be noted here that the seemingly unrestricted planning authority of the commune experiences further restrictions also in the case of changes in the destination of agricultural land of high class. In this case, only the will of the commune authorities is not sufficient to change their destination (as it is the case with land in classes IV-VI). The consent of the minister in charge of rural development (acting as an agricultural land protection authority) is also necessary when the allocation of agricultural land in categories I to III, i.e. the highest land classification classes available in Poland, is changed. Thus, the possibility of any transformation of land subject to special protection is secured due to its high usefulness in agriculture.

The role of the state (in the discussed case acting through the minister) is to protect agricultural and forest land and to enable their best use. Legal protection of land aims at counteracting the contraction of agricultural resources by introducing, on the one hand, procedures conducive to effective use of land and, on the other hand, limiting exclusion from agricultural use of soils of particular cultivable value (Panek, 2018, p. 4). Agricultural land is an example of a specific category of goods, used in almost all areas of human activity. The progressive development of civilization, including industrial development, but also the increase in the population, contributes to a continuous increase in demand for this type of good. Research indicates that the land flow between particular economic sectors is most often one-way in

nature, i.e. land changes its use from agricultural to non-agricultural purposes, while land reclamation is extremely rare (Górska, Michna, 2010, p. 58).

However, the minister's consent to a change in the use of land of a higher category is not required in all cases. The Act on the protection of agricultural and forestry land also provides for exceptions to the need for an appropriate agreement (figure 1).
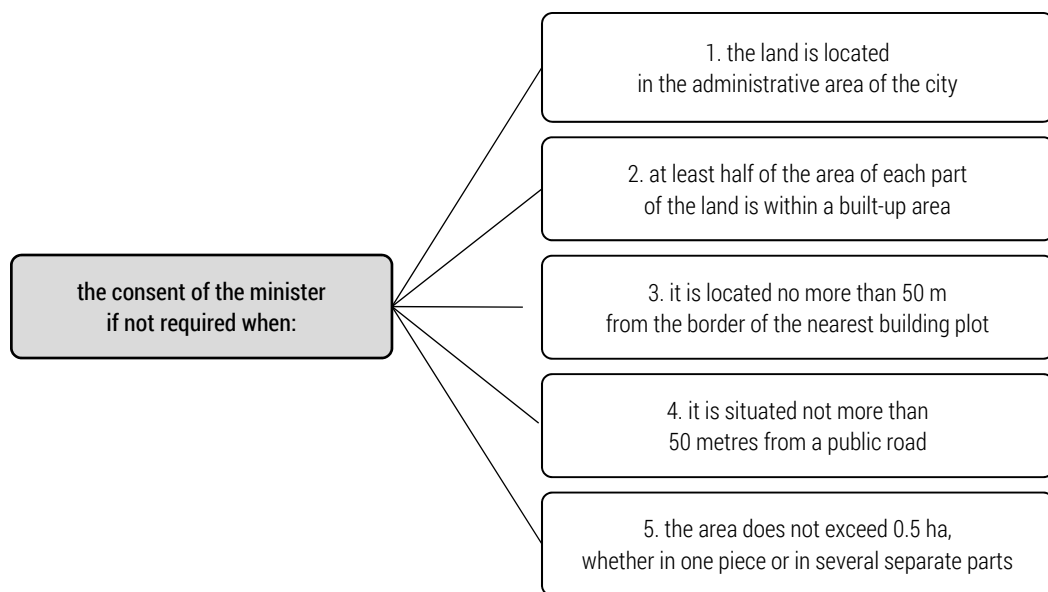
Figure 1. The omission of the Minister's consent to the transformation

Source: author's own work based on art. 7 of the act of 3 February 1995 on the protection of agricultural and forestry land.

In relation to the above drawing, it should be pointed out that the premise from point 1 is of an independent nature, i.e. the mere statement that the land lies within the administrative boundaries of the city means that it does not need to undergo the transformation procedure (the mere subsequent exclusion of the land from agricultural production is sufficient). However, the conditions from points 2 to 5 must be met jointly so that the executive body of the commune can disregard the agreement procedure for the highest class land when drawing up the LSDP. For a fuller understanding of the above conditions, the notion of "compact development" referred to in point 2 should also be understood as a grouping of no less than 5 buildings, except for buildings with a purely economic function, where the greatest distance between adjacent buildings does not exceed 100 meters (judgment of the Regional Administrative Court in Rzeszów, 2017, II SA/Rz 312/17).

The procedure of adopting local spatial development plans in Poland is regulated by the provisions of the Act of 27 March 2003 on spatial planning and development (Journal of Laws No. 80, item 717, as amended). This results in several circumstances that are important from transformations. It should be remembered that the adoption or change of the LSDP may take place at the request of the investor addressed to the head of the commune (mayor of the city) or ex officio by the executive body of the commune.

As an introduction, it should be noted that when examining the application for a plan, the mayor takes into account the legitimacy of introducing changes to the LSDP in terms of its compliance with the study of conditions and directions of the spatial development of the commune and prepares appropriate documentation (surveying, and financial). If the investor's request is accepted, the mayor shall submit the request to the commune council to adopt a resolution to proceed with the adoption/amendment of the local spatial development plan in force. Importantly, the motion to adopt the plan is exempt from any fees.

As follows from the provisions of the Act on spatial planning and development, the procedure of adopting and amending the LSDP in at least a few places (in its initial and final part) requires that the authorities conducting it consult the matter being developed at a given moment with representatives of the society, i.e. de facto owners or investors of land covered by the future plan. This is also of considerable importance in the context of land-use change for non-agricultural purposes.

From the very beginning, when the plan does not even have a project form yet, all interested parties (i.e. owners, users, but also third parties) can comment on the future use of the land. Even after agreements have been made (e.g. with the minister in charge of rural development), the public may express their opinion on a ready-made draft plan and express their possible dissatisfaction. This is also the last moment to introduce changes to the plan. An extremely important element is also the possibility to appeal the ready plan to the locally competent Regional Administrative Court, which assesses the procedure and substance of the LSDP from its compliance with generally applicable law (Szustakiewicz et al., 2016).

Confirmation of the above also results from the practice of law. The Supreme Administrative Court in Warsaw in one of its judicatures stated, inter alia, that entities actually interested (positively or negatively) in the change of agricultural land use for non-agricultural purposes, before the commune applies for permission, may express their intention with regard to the use of real estate by submitting planning applications to the commune. (...) Only when the commune council adopts a resolution adopting the local spatial development plan, pursuant to Article 101 paragraph 1 of 15 Septem-

ber 2017 (Journal of Laws of 2017, item 1875), the owners (perpetual usu-fructuaries') of real estates included in the plan will have the right to file a complaint with the administrative court against this resolution (judgment of the Supreme Administrative Court in Warsaw, 2017, II OSK 2279/15).

It is well known, however, that the local spatial development plan is not an obligatory document. The lack of a statutory obligation for Polish munici-palities to draw up local plans translates into the state of their coverage.

Referring to statistical data (the Local Data Bank of the Central Statistical Office), a systematic increase in the coverage of the country with the local spatial development plans in force can be observed. In 2009, the share of the area covered by the local spatial development plans in the total area was 25.6%, in 2013 – 28.8%, and in 2018 – 30.8% (figure 2).
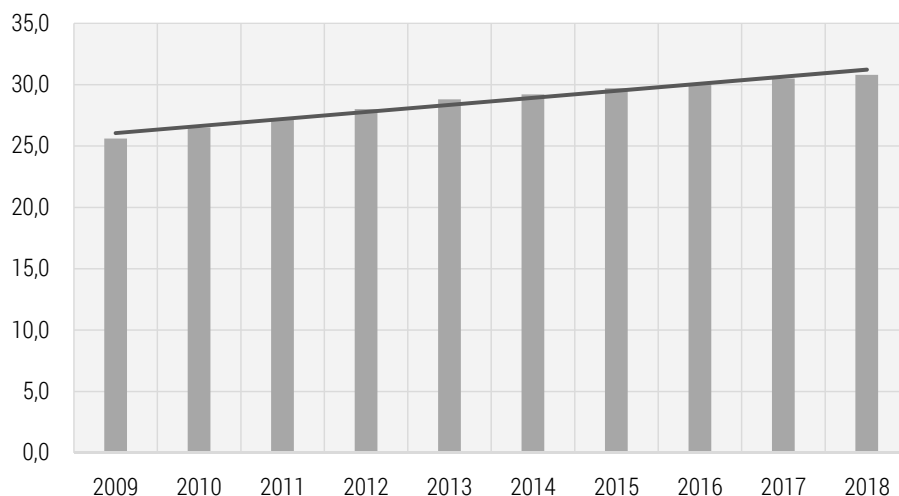
Figure 2. Share of the area covered by current local spatial development plans in the total area of Poland [%]

Source: author's own work based on data from the Central Statistical Office.

In addition to planning coverage, it is also worth paying attention to the total area of agricultural land, which were designated in plans for non-agri-cultural purposes (figure 3) and area of land indicated in the study of condi-tions and directions of spatial management requiring to change the designa-tion of agricultural land for non-agricultural purposes (figure 4).
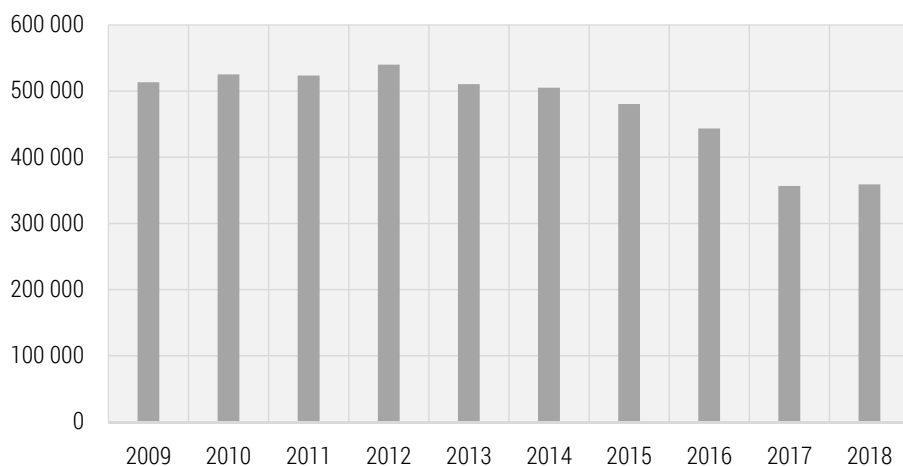
Figure 3. The total area of agricultural land, which was designated in plans for non-agricultural purposes [ha]

Source: author's work based on data from the Central Statistical Office.
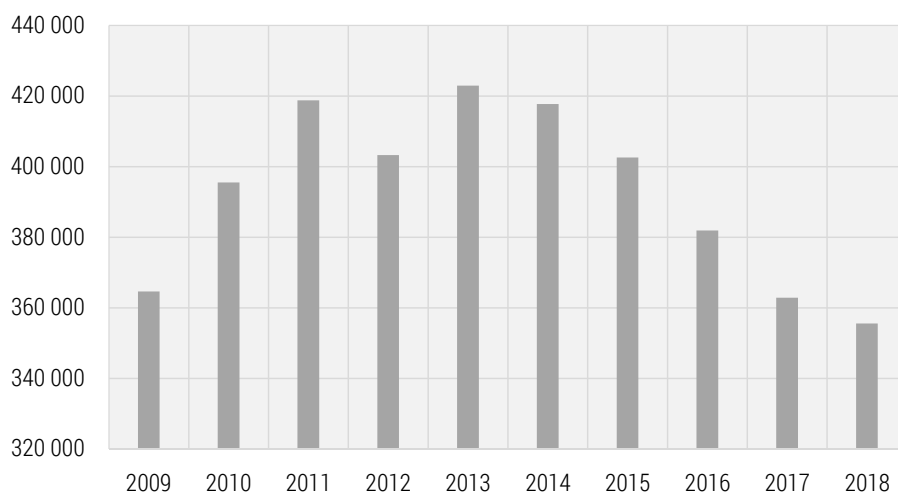
Figure 4. Area of land indicated in the study requiring to change the designation of agricultural land for non-agricultural purposes [ha]

Source: author's work based on data from the Central Statistical Office.

Based on statistical data (figures 3 and 4), one can notice a significant decrease in both the area of land indicated in the study requiring to change the designation of agricultural land for non-agricultural purposes, as well as the decrease in the area of agricultural land for which non-agricultural purposes were changed in local plans.

Despite the growing trend, management of modern space-based on local plans takes place only in 30% of Poland's territory, in other areas the basis for spatial planning are the so-called decisions on zoning and development conditions, which can be divided into decisions on zoning conditions and decisions on determining the location of public purpose investments – concerning only the objectives referred to in Article 6 of the Act of August 21, 1997 on real estate management (Journal of Laws of 2015, item 782 with amendments). The number of decisions issued in recent years is shown in figures 5 and 6. It is worth noting that the number of decisions on zoning conditions systematically decreased until 2015, after which it increased to over 146 thousand in 2018. Importantly, most of the decisions on zoning conditions in 2018 concerned single-family housing (figure 7). In the case of the decision on determining the location of public purpose investments, their number increased in the analyzed period, in 2018 over 28 thousand were spent, which may indicate increased investment activities in Poland.
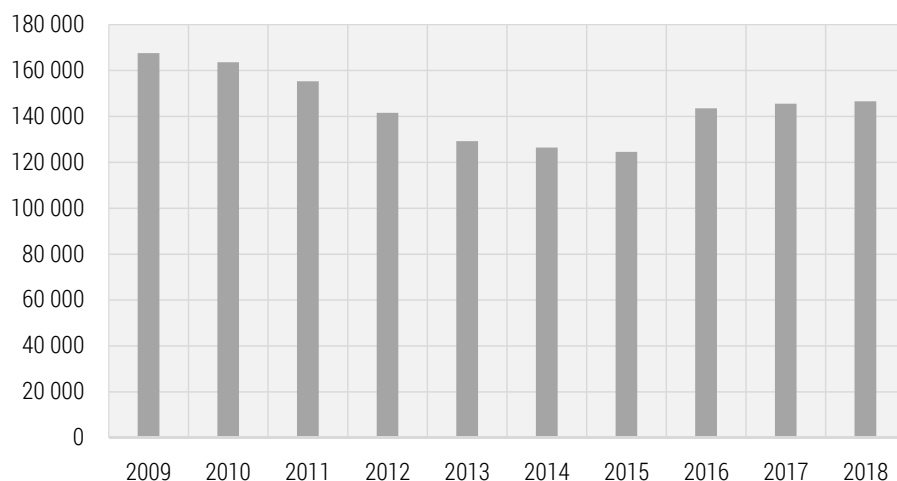
Figure 5. Land development decisions total

Source: author's work based on data from the Central Statistical Office.

Due to the subject of considerations undertaken within the framework of this work, special attention must be paid to the decision on zoning conditions (also: development conditions) – because it is a measure to change the purpose of land use in the absence of a local spatial development plan. The basic principles of its issuance are regulated by Article 61 of the Act of 27 March 2003 on spatial planning and development. In the judgment of 14 May 2015,
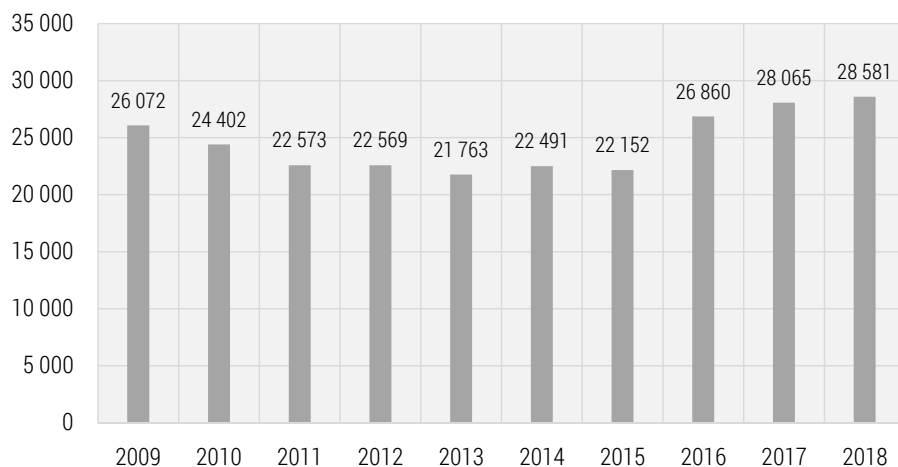
Figure 6. The decisions on the land location of public purpose investment
Source: author's work based on data from the Central Statistical Office.

- decision regarding the multi-family house
- decision regarding the single-family house
- decision regarding the service buildings
- decision regarding other buildings
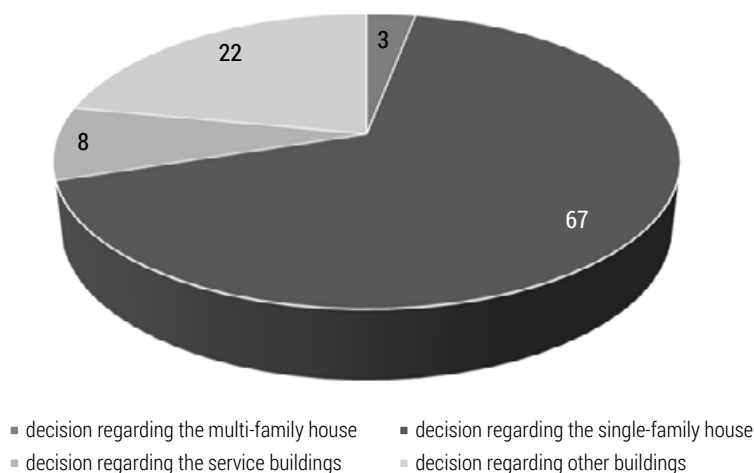
Figure 7. The share of decisions regarding individual types of buildings in the total number in 2018 [%]

Source: author's work based on data from the Central Statistical Office.

II SA/Op 112/15, the Regional Administrative Court (WSA) in Opole stated that "the decision on development conditions is not discretionary; hence the competent authority should determine the development conditions if the investment intention satisfies all the conditions specified in Article 61(1) of

the Act on Combating Unfair Competition. A refusal may be refused only if the investment does not meet at least one of the statutory conditions".

The statutory prerequisites for issuing a decision on land development conditions, apart from the principle of good neighbourliness, the need to have access to public roads and utilities, and compliance with separate regulations, are also the condition that the land does not require a permit to change its use for non-agricultural purposes issued by the minister in charge of rural development.

Taking into account the previous considerations regarding the conditions for obtaining the minister's consent, it should be stated that a decision on development conditions changing the use of land may be issued only in the case of soils of lower grades of land classification, whose change of use does not require the consent of the Minister for Rural Development.

However, if such consent is not required, a decision on land development and land use conditions is sufficient to change the use of agricultural land (Supreme Administrative Court judgment in Warsaw, 2010, II OSK 299/09). In other words, it is not possible to change the use of agricultural land for non-agricultural purposes by issuing a decision on development conditions in a situation where the land is not used for agricultural purposes:
• the land is of high quality (I-III) and,
• there are no prerequisites under Article 7(2a) of the Act on the Protection of Agricultural and Forestry Lands (judgment of the Regional Administrative Court in Warsaw, 2009, IV SA/Wa 679/09).

In such a case, the investor must seek to adopt a local spatial development plan for his land, but if such a plan exists (but the land remains agricultural land under its provisions), it will be necessary to amend the plan, which does not procedurally differ from the proceedings for its adoption.

The exclusion of land from agricultural production – the second stage of conversion

After the change of land use (as a reminder – either by way of a resolution/modification of the LSDP, or after the decision on development conditions becomes final), before the commencement of non-agricultural land use, the investor may be obliged to obtain an administrative decision on the exclusion of land from agricultural production.

An investor will be required to apply for such a decision if the agricultural land falls into the following categories:

Figure 8. The exclusion of land from agricultural production

Source: author's work based on art. 2 of the act of 3 February 1995 on the protection of agricultural and forestry land.

Unfortunately, the problem arises when the land has to be classified according to its origin (organic or mineral), in particular as regards lower categories of land (IV-VI). In practice, the owner often does not know what the origin of the soil is and therefore applies for land to be excluded from agricultural production 'just in case'. In such a case, the authority conducting the proceedings (the locally competent starost) should discontinue the proceedings to the appropriate extent (mineral soils) and inform the party about it in writing. The basis for determining the origin of soils are soil and agricultural maps, prepared and made available by the Chief Surveyor of the Country, and in case of doubt, the starost may additionally ask a soil expert to prepare an appropriate opinion (Wszołek et al., 2016, p. 4).

The decision to exclude land from agricultural production is subject to the payment of exclusion fees. We can divide them into one-off and annual fees. What is important, these receivables are reduced by the value of land, determined according to market prices applied in a given locality inland

trade, on the date of actual exclusion of this land from production. The relevant assessment report must be submitted by the applicant when applying for a decision to set the land aside from agricultural production. The fee rates vary from 437.175 PLN per 1 ha (best classes) to 87.435 PLN (worst class) For more specific information art. 12 of the act of 3 February 1995 on the protection of agricultural and forestry land. A one-off fee in the specified amount (reduced by the value of the land) is payable within 60 days from the date on which the decision to exclude a given land from agricultural production becomes final and binding. Annual fees (10% of the one-off fee) are payable for 10 years by 30 June each year. Transformation fees shall not be charged:

- investors whose land does not require a decision to exclude land from agricultural production,
- Investors intending to use their land for housing development are also exempt from the obligation to pay fees, however, up to a maximum of 0.05 ha (in the case of a single-family building) or 0.02 ha (for each residential unit in the case of a multi-family building).

The exclusion of land from agricultural production completes the procedure for converting agricultural land into non-agricultural purposes. A positive conclusion of this procedure allows the investor to apply for a building permit (Siwkowska, 2019, p. 42). However, one should not forget that the legal, actual exclusion of land from production may take place only when the decision on exclusion becomes final, i.e. when it is not effectively appealed against, or when a higher-level body maintains the decision of the first instance body (Supreme Administrative Court in Warsaw, 2016, OSK 224/15).

Finally, it requires an indication of the legal consequences that investors may face when they start non-agricultural use of agricultural land without the required decision. According to Article 28 of the Act on the protection of agricultural and forestry land, if it is found that land has been excluded from production contrary to the provisions of the Act, the perpetrator of the exclusion shall be charged twice the amount of the fee. There shall be no reduction in its amount by the value of the land, as in the case of a lawful exclusion. As indicated by the Supreme Administrative Court in Warsaw: "Deduction of receivables by the value of land is a solution adopted by the legislator for situations regulated in Article 12 of the Act of 3 February 1995 on the Protection of Agricultural and Forestry Lands (Journal of Laws of 2017, item 1161) (i.e. legal exclusion of land from production) and constitutes an extraordinarily "addition" to the receivables themselves, just as such a special "addition" is a doubling of receivables referred to in Article 28 paragraph 1 of the aforementioned Act. Article 12(6) and (11) of the Act do not apply to the determination of the fee pursuant to Article 28(1) of the Act – the fee referred to in

Article 28(1) of the Act cannot be reduced by the value of land determined in accordance with market prices applied in a given locality on the date of actual exclusion of that land from production, as is the case when a permit to exclude land from production was obtained (judgment of the Supreme Administrative Court in Warsaw, 2017, II OSK 985/15).

Moreover, if it is found that land designated in a local spatial development plan for non-agricultural purposes was excluded from production without a decision to exclude the land from agricultural production, such a decision is issued ex officio, increasing the amount due by 10%.

Therefore, it should be stated that the legislator, by introducing the above mentioned, very strict regulations, aimed at effectively stopping investors from arbitrary commencement of non-agricultural land use.

Conclusions

The procedure for the transformation of agricultural land into non-agricultural land allows the investor to start non-agricultural land use. It should be noted, however, that for some categories of agricultural land (in particular the highest classes) the change of their designation for the majority of investors will, under the current law, be excessively difficult or even impossible. It may cause a halting of the process of gradual development of urban and rural areas in favour of maintaining strictly the agricultural function of land properties, which may adversely affect the sustainable development of these areas.

This is because, in the light of progressive changes in the Act on Protection of Agricultural and Forestry Lands, it is increasingly difficult to obtain a change in the use of agricultural land. Currently, the policy of the Polish State is focused on the protection of these lands, and the decisions made at the central level are discretionary, i.e. almost entirely dependent on the will of the authority.

Also, agricultural land covered by local spatial development plans is extremely difficult to "changing the status of farmland" in the Polish legal system. This must entail the whole procedure of changing the local plan, which, taking into account the time and costs, may in many cases turn out to be unrealistic (especially when one investor applies for a change of plan).

Not without significance for the process of land exclusion from agricultural production are also the extremely high fees associated with it. This may be a barrier that many investors will not be able to overcome on their own. On the other hand, the possibility of excluding agricultural land for housing purposes from agricultural production and the related exemption from the obligation to pay transformation fees should be assessed positively due to

the insufficient number of residential premises per capita in Poland. It seems that one should consider extending the exemption in this respect, because very often the possibility of paying such high fees may exceed the budget of potential investors, in particular in the context of other necessary expenses related to the investment process.

Finally, it should be noted that not only the Act on Protection of Agricultural and Forestry Lands provides (in some cases) for a facilitated way of changing the destination of agricultural land. As a result of the building firms' lobby in Poland, the Act of 5 July 2018 on facilitating the preparation and implementation of housing investments and accompanying investments (Journal of Laws of 2018, item 1496) – the so-called Special Construction Law – was passed.

Article 39 of the Special Act indicates that: "the provisions on the protection of agricultural land and forests concerning agricultural land do not apply to the housing or associated investment within the administrative boundaries of the cities. Such a solution, commonly referred to as "automatic reversal", is provided only for developers building blocks of flats or houses according to the path provided by the Act (alternative to the regulations on planning and spatial development). Importantly, the possibility to avoid formalities and costs related to the exclusion of land from agricultural production has been created by the government only for investors building at least 10 single-family houses or 25 residential units. However, this does not undermine the fact that private investors cannot take advantage of the abovementioned Special Act, which makes it necessary to undergo the procedures described in this article.

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STUDIES
AND MATERIALS

STUDIA
I MATERIAŁY

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HARMONIZATION OF CRITERIA AND OPERATIONALIZATION OF SUSTAINABLE DEVELOPMENT INDICATORS IN THE ASSESSMENT OF BIOPRODUCTS

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ABSTRACT: This article analyses sustainable development indicators for the assessment of bioproducts. It also determines criteria for the operationalization of bioproduct assessment on the basis of available literature on the subject and the opinions of entrepreneurs producing packaging made of petroleum derivative materials. The results of literature and questionnaire studies indicate that indicators used for the assessment should accurately reflect the process or state of affairs they present, and be clear for every stakeholder throughout the entire supply chain.

KEY WORDS: bioproducts, assessment, SD indicators, operationalization

Introduction and methodology

The golden age of the plastics industry resulted from the industrial revolution and technical progress. Over time, plastics found a number of applications, including use in construction, electronics, medicine, aviation and many other industries (Piontek, 2019, p. 19).

Over the past 70 years, world plastics production had increased from nearly 0.5 million tons in the mid-twentieth century to over 365 tons in 2016. After China, Europe is the world's second-largest producer of plastics (Dobrucka, 2019, p. 129). In medium- and underdeveloped countries, the share of plastic waste in municipal waste increased by almost 10% from 1960 to 2005 (Geyer, Jambeck, Law, 2017). The reasons for this state of affairs can be traced to three phenomena: an increase in the scale of use of non-natural packaging materials, development of the disposable packaging market and the use of the packaging as marketing materials. In highly developed countries, packaging accounts for over 40% of municipal waste. In Poland, this share amounted to nearly 48% in 2017 (Piontek, 2019, p. 21).

The main advantages of using plastics include, first of all, low costs and high functionality (Piontek, 2019, p. 21). Although the use of plastics has many advantages in comparison to other materials, their disadvantages are becoming an increasing concern. PET is a carcinogen (see Sax), and the annual mass of plastic waste discharged into the oceans by rivers is 1.15-2.41 million tons (Lebreton et al., 2017). Currently, the use of virtually non-decomposable materials for packaging is being reduced (Nampoothiri et al., 2010). The obligation to change the approach to this issue has been forced by the introduction of two European documents: Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste and Directive of the European Parliament and Council (EU) 2018/852 of 30 May 2018 amending Directive 94/62/EC on packaging and packaging waste (Dobrucka, 2019).

The European Union does not use the potential arising from the recycling of plastic waste. Only 30% of nearly 26 million tons of plastic waste are recycled annually. One of the main principles of the European Commission's economic policy, adopted to protect the environment and implement the principles of sustainable development, is the circular economy. Closed circulation minimizes resource waste and reduces the scale of resource use (Stahel, 2016). This policy also applies to the packaging industry, mainly in terms of minimizing the amount of packaging waste generated from conventional plastics (Dobrucka, 2019, p. 133).

In 2018 PlasticsEurope formulated the paramount goals of the Plastics 2030 Voluntary Commitment of the Plastics Industry: preventing the release

of plastics into the environment, increasing the scale of recycling and reuse of waste and improving resource efficiency. Poland is an important participant in the European plastics market, being the sixth economy after Germany, Italy, France, Spain and Great Britain in terms of demand for plastics. The demand for plastics in 2017 in Europe was over 51 million tons. Both in Europe and in Poland, plastics are mainly used in the packaging industry (Europe 39%, Poland 34%). However, it would be best to introduce materials that completely ensure the possibility of the circular economy. Therefore, research focused on rational resource management and improving the efficiency of their use (bioeconomy) is being continued. Bioeconomy includes all sectors related to biological resources (Chył, Rzepecka, 2011, p. 3), including bioproducts.

In the 2020 Strategy, the European Union strongly supports the development of bioproducts. The importance of bioeconomy for smart and ecological growth in Europe is emphasized in this strategy. Changes in the bioeconomy will not only contribute to saving natural resources and to protecting the climate, but it is also expected that bioeconomy "is able to stimulate and maintain economic growth and create jobs in rural, coastal and industrial areas; reduce dependence on fossil fuels and contribute to improving the economic and environmental sustainability of primary production and the processing industry" (Communication from the Commission..., 2019). "The essential element of sustainable economic development in the EU and the country will be the production of products and services in a manner that ensures constant restitution of the natural environment" based on raw materials of biological origin. However, even bioproducts have an environmental impact and should be part of not only the bioeconomy but of the wider circular economy (Gołaszewski, 2013, pp. 51-54). In order to control the environmental impact of bioproducts, assessment is required throughout the entire life cycle using properly selected sustainable development indicators. In addition to the proper selection of indicators, it is necessary to operationalize them, i.e. bring the indicators and variables to a form that can be precisely expressed. Despite the huge number of indicators proposed in literature and documents of the European Union, Borychowski et al. (2016) indicate the lack of data to produce relevant aggregate indicators as the basic problem in operationalization. This is the main obstacle observed in the implementation of the concept of sustainable development (Sahely et al., 2005) at the practical level. Recommendations for current standards for sustainable development of bioproducts in the European Union require interoperability, which is a key factor in enabling digital transformation. In the case of bioproducts, it is a process of increasing information comparability by introducing a uniform set of sustainable development indicators based on common assumptions and

concepts. The problem involves the harmonization of the entire process and their proper selection to ensure the quantitative measurement and qualitative assessment of a given bioproduct and its environmental impact. Therefore, the question arises: how should sustainable development indicators used in the assessment of bioproducts be characterized, so that they can be a practical tool at every stage of the life cycle?

The article is aimed not so much at preparing a finished list of indicators as it is at indicating the path of their selection. It is an attempt to determine the criteria for the operationalization of bioproduct assessment based on available literature and opinions of entrepreneurs who are producers of packaging made of petroleum derivative materials.

Due to the nature of pilot studies, the analyses were narrowed to one voivodeship. In the first stage, using the search engine – Panorama Firm – companies registered in the Warmia and Mazury Voivodeship were identified, whose common feature was the production of packaging from petroleum derivatives. In this way, 35 enterprises were selected. Surveys were conducted among decision-makers in these enterprises.

 In the next stage, verification was carried out by interviewing the decision-makers in the enterprises to obtain consent to send the questionnaire. Twenty-four enterprises returned correctly completed questionnaires, which constituted 68% of the identified enterprises.

This was a representative sample for the studied area. The survey consisted of four closed questions and a metric that took into account the length of business operations on the market and activity in introducing innovations. Among the surveyed enterprises, eleven had been operating for over 20 years. One company had been operating for the longest time (47 years) and one company for the shortest (3 years). It should be noted that although the survival rate of companies on the Polish market is growing, the Warmia and Mazury Voivodeship is one of those voivodeships (only Kuyavian-Pomeranian Voivodeship is lower in the ranking), where young companies are doing the worst. Research shows that the third year of operations is the most difficult one, during which the funds to start up a company are often exhausted. Companies often ended their activities between the 25th and 36th month (CRIBIS.pl). Considering the length of functioning of the surveyed companies, it can be stated that they are companies with an established position and are long-term operators on the market as per Polish conditions. This may bode well in terms of the possible implementation of innovations. In addition to intellectual effort and financial resources, innovation always requires industry experience. Among the surveyed enterprises, over 90% made innovative changes in the field of technology. One of them made such changes twice in 2008 and 2018, which is worth emphasizing in this case, as the enterprise –

as the only one – started production based on oxy-biodegradable materials, and then biocomposites. This result is much higher than the average in Poland. In Poland, between 2015-2017, only 20.2% of industrial enterprises showed innovative activity. Industrial enterprises most often introduced new or significantly improved methods of manufacturing products.

The results of the survey were developed, and the structure of indications was given.

Place of bioproducts in constant and sustainable development

According to the European Standard EU (European Standard EN 16575: 2014 'Bioproducts-Dictionary), bioproducts are products made in whole or in part from biomass, i.e. biomaterials, with the exception of materials embedded in geological or fossil formations (Communication from the Commission…, 2019) On the other hand, biomaterials (in the utilitarian concept) are materials used in technology, e.g. for the production of packaging materials. According to, i.e. Malinowski (2015, pp. 215-231), three criteria for the division of biomaterials are listed: methods of obtaining them, the structure of the polymer chain, physicochemical properties and application technologies.

At the same time, the definition officially adopted by European Bioplastics defines bioplastics as biodegradable materials and/or plastics from renewable sources, indicating the biodegradability criterion and sources of extraction (European Bioplastics, 2019) From the point of view of operationalization of the environmental impact assessment of a bioproduct, the adoption of such a definition is fully justified. The definition constructed in this way indicates that biomaterials are not necessarily degradable. According to it, biomaterials also include materials that are not biodegradable, but which are made from renewable and non-renewable resources. Out of six possibilities, only one is not a biomaterial (figure 1). It is a material from fossil resources that are not degradable (non-biodegradable).

From the point of view of environmental protection, the most beneficial material is a biomaterial produced from renewable resources and, at the same time, a biomaterial that is biodegradable which, in consequence, means that the bioproduct produced is also biodegradable. Błędzki and Fabrycy (1992, pp. 343-350), Trznadel (1995, pp. 485-492) have written about it for a long time, as well as – more currently – Peneczek et al. (2013, pp. 835-846) (figure 3). The materials most commonly used in the production of bioproducts are based on starch, polylactic acid (polylactide, poly (lactic acid), PLA), polyhydroxyalkanoates, alkanoates (PHA's: PHB, PHBV etc.), aliphatic-aromatic polyesters, cellulose (cellophane, etc.) and lignin.
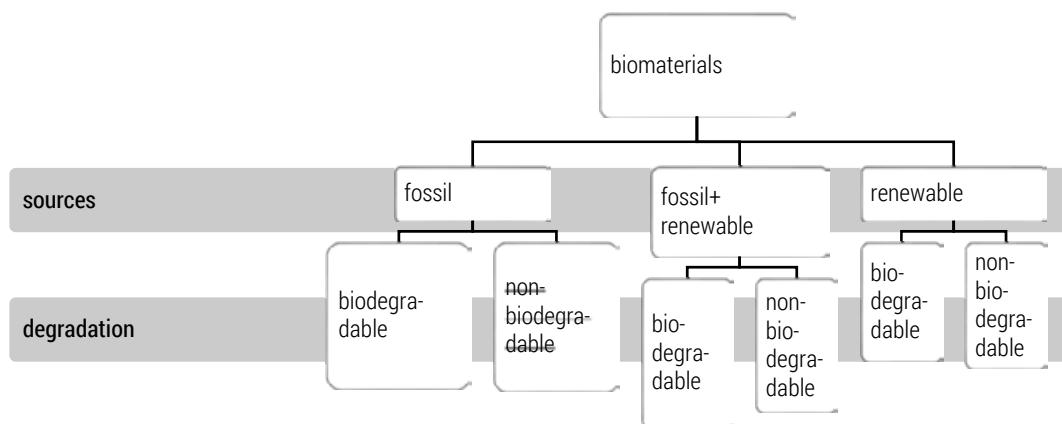
Figure 1. Division and interrelationships of biomaterials by their source and biodegradability
Source: European Bioplastics, http://european-bioplastics.org [17-09-2019].

The best solution for environmental protection and an alternative to petroleum derivative materials would be to introduce biomaterials into large-scale production and, as a consequence, bioproducts. However, in Poland, the biomaterial market is practically non-existent, despite its intensive development in the EU. EU experts expect that by 2021, the EU will be able to boast a quarter of the world's biomaterial production. At the same time, the global market is recording 20-100% growth on an annual basis. However, it should be added that the world's production of biomaterials produced from renewable and/or biodegradable raw materials is at the level of 1% (Malinowski, 2015, pp. 215-231). Malinowski (2015, pp. 215-231) indicate the reasons for low production: high costs of testing of these materials, insufficient promotion, as well as manufacturers' concerns about new, alternative products from materials with a predetermined lifetime. However, their development is inevitable. Biomaterials constitute an important element of the circular economy, which is to replace the linear economy.

It should be added that nature produces about 170 billion tons of biomass annually. Of this, 3.5% (6 billion tons) is used, of which about 62% is intended for food production, 33% for energy and paper production and 5% is processed into chemical compounds (Malinowski, 2015 after Shen et al., 2007). All of these circumstances indicate the problem of insignificant production of bioproducts. Biomaterials can be an alternative to petroleum derivative materials, although the lack of organized collection and the possibility of effective separation of waste is a significant problem. Currently, bioproducts offered on the market are in an insignificant quantity, or there are none. However, their introduction to the market is inevitable in the shaping

of the environment towards constant and sustainable development. To quote Gołaszewski (2013, pp. 51-54), *it is estimated* (OECD, 2009; The bioeconomy to 2030: Designing and Policy Agenda) *that products obtained from renewable biological resources (biomass) will gradually replace products produced from fossil fuels today, creating a new bioprocess market and, as a result, a new market for bioproducts and services – they constitute 25% of the world market.*

Problems with the proper selection of indicators for assessing the impact of bioproducts on the environment

General guidelines for the selection of indicators

Assuming the introduction of bioproducts on a larger scale in the future, it seems necessary to measure their environmental impact. Sustainable development goals related to sustainable consumption and production are only achievable if well-monitored. Babbie (2001) indicates conceptualization and operationalization among the pillars of any measurement. Conceptualization involves the specification and refining of abstract concepts, while operationalization involves the creation of specific research procedures that will allow for empirical observations corresponding to these concepts in the real world. Although the concept of sustainable development has many definitions and indicators, it is still difficult to choose the right one for its assessment. In the multitude of definitions of sustainable development, Borychowski et al. (2016) detect problems with the conceptualization of this concept, which translates into a high number of measures and sustainability indicators. The International Institute for Sustainable Development indicates the existence of 173 alternative sustainable development indicators used in various countries, and there are even more to be found in the scientific literature (Borys, 2005). However, Borychowski et al. (2016) indicate the lack of data to produce relevant aggregate indicators as the basic problem in operationalization. This is the main obstacle that is observed in the implementation of the concept of sustainable development (Sahely et al., 2005) at a practical level. There are also gaps in indicating the direction of preferences for many proposed indicators, and even contradictions depending on the component (order) that is being analysed. An indicator may take a positive direction due to, e.g. social needs, but a negative direction due to environmental protection. Therefore, it is extremely important not only to know but also understand, the direction of preferences. In current systems, this direction is not always defined, which may cause misunderstandings or misinterpretation. It must, therefore, be clearly determined whether a given parameter is a stimulus conducive to sustainable development, or on the contrary, a destim-

ulant. While in the case of the economic sphere, the highest possible values of indicators describing it are most often desirable, in the ecological sphere – the minimum environmental burden associated with production. Even for bioproducts, this burden occurs. Operationalization means bringing indicators and variables to a form that can be precisely expressed. In addition, it is also important to be able to use digital technology to assess achievements. Especially since interoperability is required in the European Union, which is a key factor in enabling digital transformation. Interoperability should be understood as the ability of a system or product to fully cooperate with other systems or products. This enables the exchange of relevant information in a way that can be understood by all parties (The new European Interoperability..., 2017) However, the adopted general principles of interoperability should be emphasized: subsidiarity and proportionality, openness, transparency, reuse, technological neutrality and data portability, user orientation, inclusion and accessibility, security, privacy and multilingualism.

Additionally, it is assumed that it should be legal, semantic, organizational and technical interoperability. This, therefore, requires harmonization. For the assessment of bioproduct indicator compliance with the principles of sustainable development, harmonization at the level of coordination, communication and monitoring of progress is necessary.

Harmony means the right order, arrangement, complementarity of elements, objects, phenomena etc. that make up a whole (Polish dictionary). The act of adapting different people, plans, situations, etc. to each other is the result of this process (https://dictionary.cambridge.org/pl/dictionary/english). Harmonization is the way to achieve the right order. In accounting, it is a process of increasing the comparability of financial statements by introducing a common set of templates based on common assumptions and concepts. This can also refer to operationalization.

Harmonization is required for cooperation in the field of bioproduct assessment criteria and operationalization of sustainable development indicators, which can thus be used by all stakeholders and at all stages of the product life cycle. They should be constructed in such a manner that they can be used to achieve purposes for which they were created and, thanks to the established uniform system, they can be fed with data at subsequent stages of the supply chain. Indicators can provide a quantitative measurement and qualitative assessment of a given bioproduct and its environmental impact (Delzeit, Holm-Müller, 2009). Indicators should be clearly worded and relatively simple to use. Goldschmidt et al. (2013) emphasize the need for indicators to have basic features. They should:
• accurately reflect the process or condition they represent,

- be sensitive enough to capture changes over time and between bioproduction and traditional systems,
- be applicable to measures in terms of time, expenditure and level of skills required,
- be clear and relevant to users at every stage of the supply chain and to end-users.

Practical tips resulting from the analysis of surveys

Due to the insignificant share of producers of biomaterial packaging in Poland, entities producing packaging made of petroleum derivative materials were selected for analysis, as potential producers. In the systemic approach to the sustainable management of natural resources, industries based on raw materials of biological origin will be a significant impulse for the development of the innovative economy (Gołaszewski, 2013, pp. 51-54). Due to this, enterprises have been characterized in terms of introducing innovation in production technology since 2005. This may indicate the openness of these enterprises to innovative solutions. Most of the respondents introduced innovations in 2005 just after Poland joined the EU and in 2015 when new funding for 2014-2020 was available, but only one innovation concerned the introduction of the production of bioproducts (figure 2).
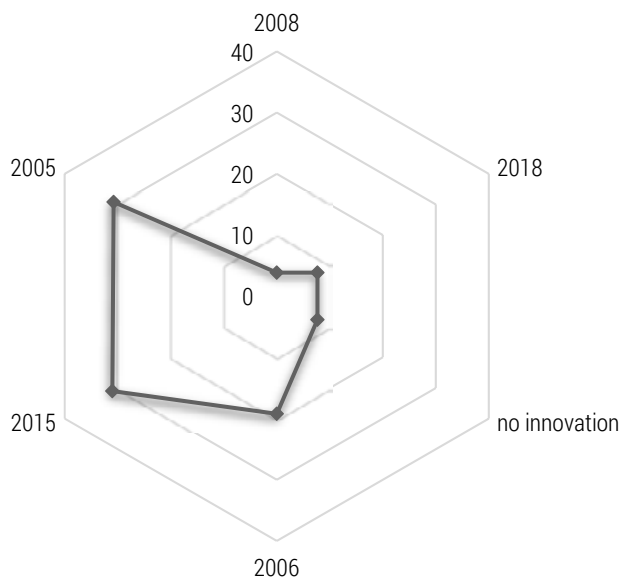
Figure 2. Structure of indications for introduced innovations between 2005-2018
Source: author's work based on a survey.

However, it should be noted that the scale of Polish bioplastics production is far behind world plastics production (Malinowski, 2015, p. 16). Among the 2,658 patents granted in 2015 in the field of biotechnology in the world, less than 2% were Polish patents. The United States, with a 37% share, is a powerhouse in this field. It should be noted, however, that approximately 2/3 of Polish patents applied for were granted (Twardowski, Woźniak, 2016, p. 158).
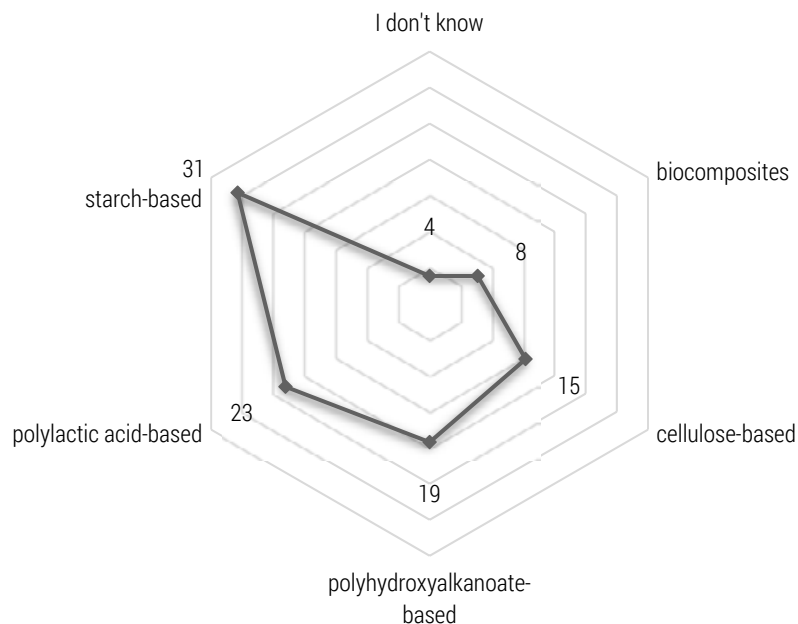
Figure 3. Structure of responses for the knowledge of biomaterials by the decision-makers [%]
Source: author's work based on a survey.

One of the biggest problems (and perhaps the reason) for resisting such innovations is poor detailed knowledge of the types of bioproducts and biomaterials among decision-makers in companies. This is revealed by the structure of the indications (figure 3). Asked about knowledge of biomaterials, entrepreneurs most often listed starch (31%) and polylactic acid 23%; only 4% of indications concerned biocomposites. It is worth adding that the company operating on the market for the shortest time gave the answer "I do not know". This is a disturbing phenomenon, given that in the near future these materials may become the most commonly used packaging materials (Dobrucka, 2019, p. 133), and the scale of their use is scarce. Of the approximately 170 billion tons of biomass produced annually by nature, only 3.5% is used by people (Malinowski, 2015, p. 219). Dynamic production, a variety of

applications and competitive performance properties can make bioplastics a material of the 21st century. Research on innovation (the propensity and the company's ability to innovate) (Stanisławski, 2015, p. 119) of enterprises shows that the main reason for moderate innovation is the lack of motivation.

Innovations constitute a priority in the socio-economic development of the European Union. In Polish conditions, innovations may be related to the implementation of the concept of the circular economy, which, by closing the product cycle and reusing it, contributes to the competitive growth and economic development of the economy due to low emissions, sustainability and competitiveness of the economy (Twardowski, Woźniak, 2016, p. 158). The theoretical foundations of the circular economy should be sought in endogenous theories of economic growth, according to which economic growth occurs as a result of introducing innovations. An intelligent, sustainable and innovative plastics sector should be shaped, based on recycling and reduction of greenhouse gas emissions. Safe consumption patterns should be created, and the use of plastics should be reduced (Piontek, 2019, p. 24).
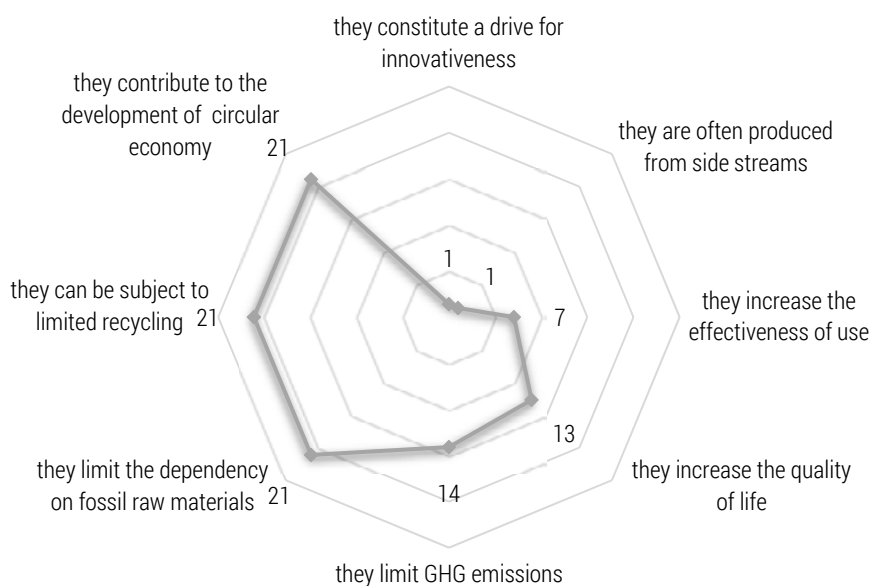
Figure 4. Number of indications of the greatest benefits resulting from the introduction of bioproducts to the economy

Source: author's work based on a survey.

Respondents were also asked to comment on the benefits resulting from the introduction of bioproducts to the economy. They were asked to indicate the three greatest benefits resulting from the introduction of bioproducts to

the economy. Despite the poor detailed knowledge, the respondents showed fairly good general knowledge about the benefits of using bioproducts (figure 4). The global economy faces numerous social challenges of a global nature. These include food security, depletion of resources and climate change (Czernyszewicz, 2016, p. 49). A further increase in the use of plastics will move humanity away from achieving these goals. The concept of sustainable development should be implemented. The goal should be to reduce the scale of the negative impact of humanity on the natural environment. Entrepreneurs mainly pointed to the features associated with the circular economy, that they can be subjected to organic recycling and emphasized the impact of bioplastics on reducing dependence on mining raw materials.

Knowledge of the benefits of using bioproducts with experience in the packaging production industry, allowed features of potential indicators to assess the environmental impact of bioproducts to be indicated. The respondents were asked to indicate the most important feature of indicators used to assess bioproducts (figure 5).
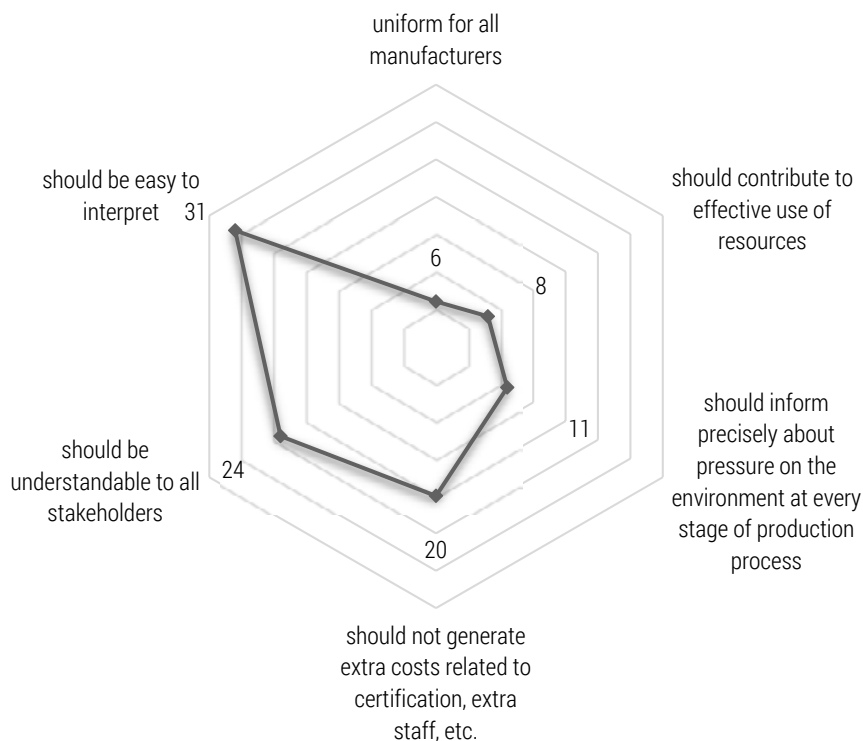
Figure 5. Structure of responses for the most important feature of the indicators used to assess bioproducts [%]

Source: author's work based on a survey.

Most indications concerned the ease of interpretation of an indicator and its understandable formula for all stakeholders. They also emphasized the need for certification costs associated with the assessment not to be high.

Conclusions

In Poland, plastics are mainly used in the packaging industry, and packaging accounts for 48% of municipal waste. The need to abandon the use of virtually non-decomposable packaging materials encourages the search for alternative solutions and including enterprises in the circular economy.

The surveys conducted among manufacturers of petroleum-based plastic packaging in the Warmia and Mazury Voivodeship showed that these enterprises implement innovations in the field of introducing bioproducts to the market to a small extent. The introduction of innovations related to the implementation of the concept of circular economy and the use of bioproducts, which are an important element of socio-economic development of the 21st century, are inevitable.

Despite little knowledge about the diversity of bioplastics, entrepreneurs are able to precisely determine the benefits resulting from their use: reducing dependence on mining raw materials, the possibility of their recycling and indicate them as important factors in the development of the circular economy. The use of bioproducts may become a source of competitive advantage of 21st-century enterprises, innovative enterprises that are socially responsible and caring for the environment. It will be possible when an efficient bioproduct assessment and control system is combined with entrepreneurs' motivation. Then there will be a chance to achieve economies of scale in the bioproduct market. The economy of scale is a measure of the change in production occurring in connection with a reduction in production costs and an increase in the consumption of resources. It is the main factor affecting long-term average total costs. In companies where there are economies of scale at the production level, the number of units produced has a significant impact on changing the long-term average cost" (Encyklopedia zarządzania, 2019). Taking into account theoretical considerations and suggestions of entrepreneurs, it should be emphasized that the indicators used must fully reflect all the environmental impacts of bioproducts indicated by the European Union: greenhouse gas emissions, water consumption, soil protection (acidification, changes in land use, use of marginal land). It would be desirable to have the environmental impact clearly visible in relation to the use of a bioproduct instead of its "traditional" counterpart. Users at subsequent stages of the supply chain and final consumers should be able to make an informed choice about a product based on such indicators. The costs related

to the assessment were also an important issue postulated by entrepreneurs. The cost of introducing an index assessment should not exceed the benefits of the assessment. Since there is already an extensive certification system for other reasons, the indicators should comply with the requirements of certification bodies (they are not superfluous, do not overlap, their significance is marginal). It is also important to know whether the data for the construction of indicators is obtainable and whether it is possible for the participants to widely use the data at every stage of production.

Indicators used for assessment ought to ensure both quantitative measurement and qualitative evaluation of a bioproduct and its impact on three pillars of sustainable development (environment, economy, society), as well accurately reflect the process or state of affairs they present. The indicators should be sensitive enough to capture changes over time and in the various biological production systems and standard production systems and relate to measures/funds in terms of time, expenditure and level of skills required. They must be understandable and relevant for users at every level of the supply chain and final customers.

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The contribution of the authors

Mirosława Witkowska-Dąbrowska – 80% (concept, methodology, literature review, conclusions).
Natalia Świdyńska – 10% (conducting a survey).
Agnieszka Napiórkowska-Baryła – 10% (development of study results).

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Urszula **MOTOWIDLAK**

THE POTENTIAL FOR ROAD TRANSPORT COMPANIES TO IMPLEMENT ADAPTATION MEASURES CONCERNING CLIMATE CHANGE

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ABSTRACT: Since transport is of great importance for sustainable socio-economic development, it is necessary to implement adaptive measures aimed at increasing the resistance of enterprises in the Transport-Forwarding-Logistics (TFL) sector to the negative effects of climate phenomena. The involvement of many entities and institutions at the national, regional, and local levels is necessary to implement effective adaptative and preventive measures. An important role in the implementation of these activities was assigned to transport companies, which are the subject of the article. Based on a survey conducted among a purposefully selected group of enterprises from the TFL sector, an assessment of the awareness of the climate change effects and the need to undertake adaptative activities was made.

KEY WORDS: road transport, CO_2 emission, climate change, adaptation to climate change

Introduction

Climate change poses a moderate threat to the current sustainable development of transport and a serious threat to the implementation of future development strategies, mainly due to the increased risk of insecurity and the lowering of transport performance standards. The process of identifying the effects of climate change on transport is a multifaceted and very complex process. The consequences of these changes may occur in the form of direct or indirect effects, and they may be measurable or non-measurable. Climate change will result in increased ocean levels, river floods, a change in the distribution of rainfall and its intensity, and extreme climatic events, among others (Rattanachot et al., 2015, p. 162). All these effects interact with each other, creating a chain of processes that is difficult to break, and causing numerous problems in the functioning of transport, especially road transport.

Governments and international communities have focused on the effects of climate change. The study of the climate change impact on transport systems indicates the risk of negative economic, social, and environmental effects (Climate impacts in Europe, 2014). One of the key challenges of the European Union's (EU) transport policy in the coming years will be to ensure the sustainable development of transport and the efficient use of environmental resources in the conditions of climate change. Reducing the sensitivity of transport to climate change will be undertaken simultaneously with the implemented activities that limit greenhouse gas (GHG) emissions (Roadmap to a Single European Transport Area, 2011). The implementation of adaptive activities is a process that requires the involvement of many entities, and entrepreneurs should play an important role in implementing them. The aim of the article is to assess both the awareness of the effects of climate change and the need for transport companies to undertake adaptive activities. The assessment was made on the basis of the results of a survey carried out among a purposefully selected group of Transport-Forwarding-Logistics (TFL) enterprises in Poland.

The effects of climate change in transport as a research area

On the basis of an analysis carried out by the European Topic Center on Climate Change Adaptation (ETC/CCA) at the European Environment Agency (EEA), one can say that one of the sectors of the European economy that is highly sensitive to climate change is transport (EIONET, 2018). The assessment of the potential consequences of climate change in transport is a relatively new but rapidly growing area of research. In Schmidt and Fleig's

assessment of the integration of climate policy objectives with the objectives of individual sectoral policies, in the 171 countries covered by the study, a systematic increase in the importance of climate change issues in transport development strategies was identified (Schmidt, Fleig, 2018, p. 179).

The results of the research presented by the EEA confirmed that climate change has an enormous impact on transport (EEA, 2014). The vast majority of transport infrastructure elements and means of transport are exposed to the direct impact of climatic factors. Analyzing the potential effects of climate change on transport, it can be predicted that some will positively affect its effectiveness, e.g., reducing the ice cover of the seas and rivers. However, most of the consequences of climate change will have a negative impact on transport efficiency (Moretti, Loprencipe, 2018, p. 3). The sensitivity and impact of climate change can be analyzed in relation to each type of transport. Road transport, due to its spatial character, is particularly sensitive to changing climatic phenomena (table 1). It is anticipated more intense precipitation events will result in the deterioration of road safety due to the increased frequency of accidents. Precipitation may also increase transport bottlenecks, especially during rush hour. In addition, climate change may cause disturbances in the functioning of road infrastructure. The increased frequency of high temperatures as well as temperatures close to 0°C in the absence of snow cover causes faster degradation of the surface condition.

Table 1. Impact of climate change on road transport

Climate factors/their impact	Effect	Signs of the negative impact of climatic factors on road transport infrastructure and services
Temperature		
High temperatures	Overheating	Destruction of road infrastructure; Reduction in the reliability of electronic components of infrastructure and mean vehicles; The instability of slopes in mountainous regions.
Sudden changes in temperature	Material tension	Signalling problems; Hillside fires;
Change of freezing and thawing cycles	Soil erosion, fog	Rapid degradation of the surface condition; The necessity to conduct earthworks.
Precipitation		
Heavy rain	Landslides, floods	Decrease in traffic safety in road transport; Delays in transport services; An increase in the number of inspections of tunnels, bridges, etc.

Drought	Drying	Decrease in traffic safety in transport (dust); Faster tread wear of motor vehicle wheels; Increased abrasion of mechanical components of infra-structure and mean vehicles.
Snow and ice	Heavy snowfalls, avalanches	Decrease in traffic safety in road transport; Delays in transport services;.
Wind		
Storms on land	High wind force, fallen trees	Decrease in traffic safety in transport; Delays in transport services.
Atmospheric discharges	Surges	Disruptions in the operation of traffic control systems in road transport; Disturbances and a decrease in road safety.

Source: Motowidlak, 2016, p. 98-99.

Depending on the scenario of climate change, the GDP forecast for 2100 may be at least 190 billion EUR annually, which is 1.8% of the current EU GDP. The biggest losses will be borne by the southern and south-central EU regions, which will account for 70% of the EU's financial losses due to climate change. Global warming will affect Northern Europe the least; their share in these losses will amount to about 1%. On the other hand, North-Central Europe, including Poland, will bear 24% of the total financial losses caused by climate change. Analysis conducted by an international team of experts, as part of the WEATHER and EWENT projects, shows that due to extreme weather events, the total costs borne by European transport could increase from 3.5 to 15.0 billion EUR per year to 2070 compared to the 2010 costs, i.e., the base year. In road transport, the annual increase in these costs between 2040 and 2070 could amount to EUR 6 billion, mainly due to higher infra-structure costs (EEA, 2017). Therefore, the consequences of climate change are determined by new areas of research which make it possible to assess the degree of sensitivity, vulnerability, and adaptability of transport.

CO_2 emissions in transport

Observational and model studies of temperature change show that the CO_2 emissions associated with human activities have caused atmospheric warming of at least 0,3°C over the last 15 years (IPCC, 2014). At the same time, scientists warn that by the end of the 21st century, the CO_2 and CH_4 emissions accumulated in the atmosphere could largely be responsible for producing global warming 2-4°C above the pre-1850-1900 levels. In a special report prepared by the Intergovernmental Panel on Climate Change concern-

ing the effects of an average increase in surface temperatures, scientists confirm that exceeding the threshold by more than 1.5°C increases the risks associated with long-term, irreversible changes (IPCC, 2018). Stopping global warming at 1.5°C, according to the Paris Agreement, will require rapid changes, including in the area of transport. Despite this, most of the effects of climate change will still be felt for many centuries, even if GHG emissions are reduced.

The main anthropogenic source of GHG emissions on a global scale is the burning of fossil fuels, on which EU transport is 96% dependent (EU energy and figures, 2018). Measurements of global concentrations of GHG in the atmosphere show a significant increase. In comparison with the data from 1995, their growth in no sector of the EU economy was as high as in the case of transport.

Calculations were made for a linear development trend model using statistical data on GHG emissions, expressed in million tonnes of CO_2 equivalent, in individual sectors of the EU economy in the years 1995-2015:

$$Y_t = \alpha_0 + \alpha_1 T_t + \varepsilon_t, \tag{1}$$

where:
Y_t –   total GHG in million tonnes of CO_2 equivalent,
T_t –   time variable which accepts the following values: 1, 2, ..., 16,
α_0, α_1 –   structural parameters of the model,
ε_t –   random variable.

The results presented in table 2 show that in industry, households, agriculture, services, and other sectors, there was a systematic decrease in GHG emissions, as the a_1 scores for these sectors are negative.

Table 2. Parameter evaluations and statistical characteristics for the trend model

Specification	a_0	$t(a_0)$	a_1	$t(a_1)$	Se	R^2
Industry	1191.59	69.94	-11.84	5.91	30.17	0.744
Household	850.04	101.45	10.57	10.72	14.83	0.909
Services	544.46	39.91	-7.14	4.47	24.16	0.622
Transport	91.98	103.34	-1.30	12.59	1.56	0.929
Agriculture	192.56	34.50	-1.29	1.99	9.87	0.247
Other sectors	2366.85	137.16	-4.50	2.23	30.55	0.290
Total	5237.59	136.25	-15.60	3.46	68.10	0.501

Source: author's work.

These ratings, except for the service sector, are statistically significant. Only for the transport sector was there a systematic increase in GHG emissions, of 10.57 million tonnes of CO_2 equivalent per year. For this sector, the highest value of determination coefficient $R^2 = 0.909$ was also obtained.

The subject of the analysis was also the volume of GHG emissions (in millions of tonnes of CO_2 equivalent) by particular branches of transport in the EU between 1995 and 2015, based on which calculations were made using the linear development trend model. The calculation results for this model are presented in table 3.

Table 3. Transport – parameter evaluations and statistical characteristics for the trend model

Specification	a_0	$t(a_0)$	a_1	$t(a_1)$	Se	R^2
Road transport	786.59	129.11	11.50	14.96	10.38	0.955
Railway transport	10.79	84.20	-0.22	12.20	0.22	0.930
Air transport	99.00	37.21	4.71	14.01	4.51	0.946
Shipping	18.53	29.59	0.21	2.72	1.08	0.402
Total	1030.31	164.28	21.45	27.14	10.68	0.984

Source: author's work.

The results presented in table 3 show that there was a systematic increase in the examined period for road transport, air transport, total navigation, as well as for total GHG emissions. This is evidenced by the positive assessment of a_1 parameter α_1. These ratings are statistically significant. There are also high values (except for shipping) of R^2 coefficients of determination, which range from 0.946 (for air transport) to 0.955 (for road transport) and up to 0.984 for total GHG emissions. The greatest impact on the growth of GHG emissions, in general, was due to road transport (11.50 million tonnes of CO_2 equivalent) and air transport (4.71 million tonnes of CO_2 equivalent). Only rail transport recorded systematically decreasing GHG emissions – by 0.22 million tons of CO_2 equivalent per year. The a_0 and a_1 ratings are statistically significant in this case. A high degree of concordance between the theoretical results and the empirical data was also obtained. This is evidenced by the high value of the determination coefficient, which is 0.930. This is also confirmed by the low value of the standard residual deviation, which in this case is 0.22 million tons of CO_2 equivalent.

The analysis of the statistical data collected in the Eurostat database (EU transport in figures, 2017) on the volume of GHG emissions in individual sectors in the EU between 1995 and 2015 confirms the growing importance of

transport policy in the context of mitigating and adapting to climate change. Special attention should be given to road transport.

Adapting road transport to climate change

### Planning adaptation activities in road transport

Adapting to climate change means increasing the resilience of the economy and society to the negative effects of current and predicted climatic events (White paper, 2009). Increased protection is determined by having an effective and efficient response to emerging extreme weather phenomena. The increased road transport capacity to deal with the inevitable effects of climate change makes it necessary to take adaptation measures. The essence of these activities is to use opportunities and reduce economic and social risks resulting from the increase in the frequency of extreme snowfall, heavy rain, as well as wind, heat, and the temperature fluctuating around 0°C.

The process of adapting transport to the effects of climate change on the territory of the EU is already taking place. However, in most EU Member States, it requires a coherent approach and improved coordination at different levels of planning and management. One of the main principles of adapting sectors that are vulnerable to climate change is the win-win rule. It should be understood as the basis for choosing activities that, while pursuing one specific goal, contribute simultaneously to achieving other important social, environmental, and economic goals (Ministry of the Environment, 2018). The actions undertaken in road transport for adapting to climate change require a strategic approach that guarantees cohesion in individual transport subsystems and sectors of the economy. Good examples of such activities are investing in the development of low-emission transport, for example, by introducing new propulsion and alternative fuel technologies and promoting energy efficiency. Increasing road transport capacity to adapt to climate change also means modernizing transport infrastructure or building blue-green infrastructure. The implementation of these adaptive measures has many positive consequences other than just reducing the effects of climate-related hazards. It favors, among others, improving the competitiveness of transport and the economy as well as the quality of life of society.

Understanding the nature of the negative effects of climate change on road transport, and indirectly on the functioning of other sectors of the economy, has prompted some EU countries to identify the necessary adaptive measures in the design, construction, and operation of transport infrastructure. One example is France, where a review of standards and guidelines for the design, maintenance, and operation of road infrastructure was completed

in 2015. As a result, several hundred technical standards were changed, including over 800 for roads. The ultimate goal of this review is to adapt road infrastructure, especially with long service periods (sometimes 100 years and more), to future climatic conditions and to support greater resilience to the effects of extreme weather events. At the same time, long-term savings in operating costs and the maintenance of transport infrastructure are expected (Ministry of Ecology, 2015). The information available on the European Adaptation Platform Climate-ADAPT, which resulted from a review of 61 adaptive activities, provides further examples of transport adaptation, including road transport, to climate change (Climate change, 2018). Aparicio emphasizes that most of these activities are local and focused on short-term implementations with immediate effectiveness (figure 1a). They mainly concern the modernization of transport infrastructure, i.e., "Engineering resilience" (Aparicio, 2017, p. 3531-3532).
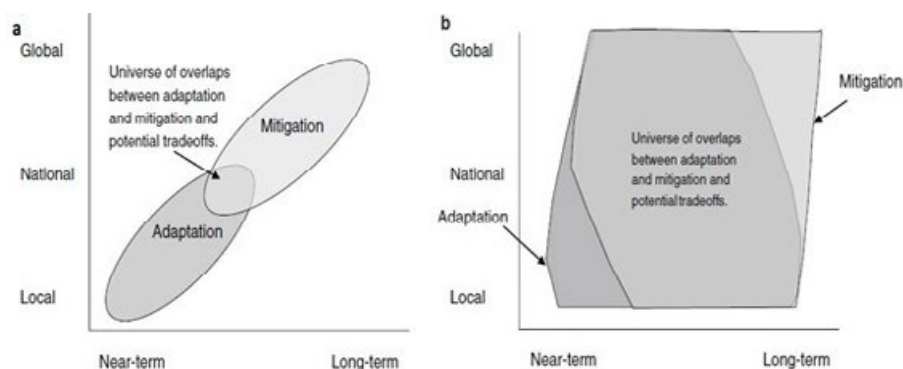
Figure 1. Overlap of Adaptation and Mitigation and the Universe of Potential Tradeoffs
Source: Aparicio, 2017, p. 3531.

Meanwhile, from a long-term perspective, it is important to increase the robustness of the transport system (figure 1b). This will be favoured by ensuring a common approach and consistency between climate change mitigation strategies and plans for adapting to these changes, among others, thanks to modal changes, the development of low-carbon transport, the dissemination of information and communication technologies (ITCs), and a change in public awareness. The effectiveness of these activities will depend to a large extent on the decisions of managers of shipping and transport companies

The importance of adaptive activities to climate change in the assessment of TFL representatives

The development of road transport in the conditions of climate change requires that effective adaptive and preventive measures be undertaken (Ministry of the Environment, 2013). The construction standards that have been developed, as well as ways of managing communication routes, may prove insufficient in the context of challenges related to adapting to climate change. Effective adaptation is not possible without an adequate level of awareness of the hazards and the need to undertake adaptive activities by transport companies. The results of the study, in which assessments of adapting to climate change in road transport were key issues, revealed the significance of these aspects.

Methods

The analysis of the literature on the subject and the activities resulting from the climate policy made it possible to identify essential adaptive measures to climate change in road transport, which are presented in table 4. The significance of these activities was assessed based on a questionnaire survey carried out online. The time range of the study covered the period from January to February 2019. The survey was completed by 78 owners of companies operating in Poland that belong to the TFL sector. Over 3/4 of them are small companies, employing up to 9 people. They ship mainly to the countries of Southern Europe, Great Britain, and Scandinavia. This was a pilot study, and due to the size of the research sample, the results should not be extrapolated to the entire truck transport services sector in Poland. Despite this, the research made it possible to estimate the importance of individual adaptive measures in road transport. The results of this evaluation will be used to refine the directions for further research.

The logic of the questions and the rules of providing answers were related to the degree of acceptance. In order to measure the intensity of "agreement" with the statements, a five-point Likert scale was used. The answers were scored as follows: 5 – strongly agree; 4 – agree; 3 – undecided; 2 – disagree; 1 – strongly disagree. The variability of responses regarding individual items of the scale contained in the question was estimated based on percentages, and then measures of variation.

Table 4. A set of variables to assess the importance of adapting to climate change in road transport

Symbol	Description of activities
TA	The effects of climate change pose a threat to the development of competitive road transport and require adaptive activities
Adaptation activities:	
A1	Providing information about the costs and benefits of adaptive activities
A2	Promoting insurance regarding the effects of climate change
A3	Making available knowledge platforms on the subject of climate change
A4	Using innovative ITC solutions
A5	Joint business-science-administration projects
A6	Taking into account the risks of climate change in the company's financial plans
A7	Developing adaptive strategies in the enterprise
A8	Setting up early warning systems
A9	Strengthening the resilience of transport infrastructure
A10	Modal changes and improving transport efficiency
A11	Using new drive technologies and alternative fuels
A12	Developing social attitudes which are conducive to adapting to climate change

Source: author's work.

Results

The results of the survey, presented in table 5, indicate an overall high awareness among members of the TFL sector of the effects of climate change and the need to undertake adaptive activities. All activities were considered valid. The variables perceived by the respondents as being very important include strengthening the immunity of transport infrastructure (A9), setting up early warning systems (A8), and the use of innovative ITC solutions (A4). The significance of social awareness was also high (average 3.93 and a standard deviation of 1.01).

Table 5. Characteristics of response variability

Symbol	Measurement of consent intensity [%]					Measures		
	5	4	3	2	1	Average	Variance	Standard deviation
TA	37.2	43.5	9.3	7.1	2.9	4.05	1.01	1.01
A1	20.2	44.1	6.7	18.9	10.1	3.45	1.64	1.28
A2	18.6	32.0	17.2	21.8	10.4	3.27	1.63	1.28
A3	15.6	24.7	28.5	22.1	9.1	3.16	1.43	1.20
A4	48.5	36.8	7.9	3.9	2.9	4.24	0.92	0.96
A5	16.5	25.8	26.2	21.8	9.7	3.18	1.49	1.22
A6	15.2	20.5	32.8	22.1	9.4	3.10	1.40	1.18
A7	19.6	28.2	26.2	15.6	10.4	3.31	1.54	1.24
A8	69.2	22.7	5.8	2.1	0.2	4.59	0.51	0.71
A9	86.2	11.9	1.4	0.3	0.2	4.84	0.20	0.45
A10	30.8	34.2	14.2	17.4	3.4	3.72	1.37	1.18
A11	30.7	34.9	18.5	10.7	5.2	3.75	1.33	1.15
A12	33.1	39.1	17.9	7.2	2.7	3.93	1.01	1.01

Source: author's work.

The study also featured three variables that were considered important but less relevant in the area of adapting to climate change. These are A6 (taking into account the risks of climate change in the company's financial plans), A3 (making available knowledge platforms on climate change issues), and A5 (joint business-science-administration projects). The study also shows that A6, A3, and A5 were the least significant variables to small enterprises in the TSL sector. On the other hand, variable A12 (developing social attitudes which are conducive to adapting to climate change) had a higher degree of significance for medium-sized enterprises employing between 10 and 49 people.

Conclusions

Climate change impacts on the transport systems in three different sensitivity aspects: infrastructure, transport operations and transport demand. Therefore, the potential impacts of climate change on transport cannot be overlooked. Due to the large dispersion of the supply side of the domestic TFL services market, it is particularly important to take steps to increase

adaptation potential. Small enterprises are usually underinvested and have problems obtaining external capital, so they are less able to adapt to climate change; this may reduce their competitiveness in the international transport market.

The results confirm:
- Climate change poses governance challenges at diverse scales and across the dimensions of risk and responsibility.
- The characteristics of the variability of the response indicate that the effects of climate change are perceived as a serious problem for the development of competitive road transport and the need to adapt.
- According to the questionnaires, the most important actions are based on the so-called "engineering resilience".
- The research indicates the possibility of increasing the adaptive potential of enterprises by including climate change issues in the company's strategy and financial planning, as well as developing cooperation with research and development centres, among others.

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SPATIAL ISSUES OF SHARING ECONOMY IN POLISH ACCOMMODATION MARKET

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ABSTRACT: The enormous growth of sharing economy in the second decade of the twenty-first century undoubtedly revolutionized the tourism and accommodation market around the world. The current research focuses on the sharing economy development, and it is mostly limited to popular cities and metropolis while its development and impact on other areas are neglected. The main aim of this article is to examine a relationship between the current size of sharing economy and population density, urbanization, development of professional hospitality base and tourism attractiveness. The research was based on the data from Statistics Poland and AirDNA. The results show that the number of sharing economy active rentals is not correlated with population and population density, but it is correlated with the number of traditional accommodation establishments and tourism attractiveness index. Moreover, the number of active rentals per capita is five times higher in urban than in other counties. The spatial distribution of sharing economy rentals is much more concentrated than a traditional hospitality market.

KEY WORDS: sharing economy, Airbnb, HomeAway, AirDNA, tourism attractiveness

Introduction

Renting spare rooms to strangers is not a new phenomenon, and it was common in the tourism market far before the advent of the Internet. However, the emergence of innovative platforms that were able to reduce transaction costs and endemic information asymmetry led to the exponential growth of this market which is contemporary referred to as a sharing economy. At the beginning, the sharing economy was associated with social and environmental benefits of usage of idle resources but very soon supply-side became dominated by professional players. Although the sharing economy is widely credited to a change of the competitive environment of many tourism markets, it lacks a common and universally accepted definition. The contemporary sharing economy is usually referred to as a peer-to-peer service market, and it is associated with intermediaries – platforms that facilitate market exchanges between providers and customers.

Sharing economy platforms have been established in hundreds of markets, but only two of them are referred to as iconic: Airbnb in the hospitality market and Uber in a taxi market. The major difference between those platforms is their operational area: Uber is operating only in major cities as in its case network externalities are essential, whereas the supply of Airbnb can be provided theoretically everywhere. The sharing economy in the accommodation market represents a wide and growing study area for economists, geographers, sociologists, and other academics. The current research focuses mainly on its impact on the economy and on social aspects of exchange between peers. Still, its spatial distribution remains under-researched, and the main question, where to expect sharing economy growth and which factors play a role in its development remains unanswered. In this paper, authors try to look at the distribution of sharing economy accommodation supply across one country, Poland. The main research question is therefore focused on determinants of its spatial distribution.

Spatial issues of sharing economy development

Given the fact that hospitality supply offered on sharing economy platforms is determined by the activity of individual investors and not platforms themselves, it is surprising how little academic attention is given to their spatial distribution. As the sharing economy is a relatively new market, so a list of potential factors that may explain variations of its spatial development is created on the base of theoretical studies, a research which was done on the traditional hospitality market and available studies linking spatial aspects of

sharing economy and pricing. This analysis led to an identification of three major factors that potentially can be related to sharing economy development:
- population density/urbanization,
- traditional hospitality,
- tourism attractiveness.

Population density

The sharing economy, not only within the hospitality market, is treated in the literature as an urban phenomenon (Deng, 2016; Stabrowski, 2017; Wegmann & Jiao, 2017). This can be, usually theoretically, explained by the inherent features of cities as places where an exchange is made, and it is connected with innovation which is a response to imminent city congestion. In this way, e.g. sharing economy platforms that enable car sharing is just an innovative response capitalizing upon structural inefficiencies in contemporary urban transportation services. As Davidson and Infranca (2016) point "sharing economy is actually thriving (...) because it recombines assets and people in a decidedly grounded, place-based way". In relation to the hospitality industry, the dominance of cities can also be explained in a similar way the OTAs (online travel agencies) developed in the first decade of the twenty-first century as a primary distribution channel on the traditional hospitality market. OTAs which are (similarly to the sharing economy platforms) intermediaries in the hospitality market also capitalize in the urban market, where tourism is a short-term, decisions are often spontaneous, customers value standardized product, and there are relatively little repeated visits (Pawlicz, 2019). It is important to observe that both OTAs and the sharing economy platforms have an immense negotiating power not only in relation to their providers but also in dealing with regulating bodies (Carroll & Sileo, 2014; Schegg, 2015). Cities are usually chosen as a research area for most of the academic papers about sharing economy development. E.g. Adamiak (2018) research base consisted only of the cities with a population over 100 000 while Ayoba et al. (2019) use a base of eight largest French cities. Moreover, there are almost no studies about the development of sharing economy in rural areas (Comp. Falk, Larpin & Scaglione, 2019; Pawlicz & Kubicki, 2017). As urban areas are primarily characterized by a high population density following hypotheses emerge:

H1a There is a strong positive relationship between the number of sharing economy active rentals and population across counties in Poland.

H1b There is a strong positive relationship between the number of sharing economy active rentals and population density across counties in Poland.

H1c A number of sharing economy active rentals per 1000 inhabitants is higher in urban counties than in rural counties in Poland.

Traditional hospitality base

Another group of research treats problems of the location of traditional accommodation establishments (e.g. Cró & Martins, 2018; Puciato et al., 2019). Using the evidence from Opole region, Poland Puciato et al. (2019) shows that the presence of new hotels is related to the supply of tourist services and to the intensity of competition within the industry. The likelihood of establishing a new budget hotel decreased with the rise of competition as those accommodation establishments compete mainly in price whereas the relationship between new locations for high-end hotels and the level of industry competition is positive. Another study conducted in Madrid, Spain, also shows that both agglomeration and differentiation strategies can be seen simultaneously (Urtasun & Gutiérrez, 2006).

There are studies which link the location of hotels and sharing economy providers usually within cities (Gutiérrez et al., 2017; Xu et al., 2019) but also within larger areas (Adamiak et al., 2019). Another study conducted in Spain shows a much more intense correlation between the number of sharing economy rentals and the number of tourist apartments than on the number of hotels (Martín et al., 2019). As the cost is a major factor for choosing sharing economy providers, so the correlation between the number of active rentals and all accommodation establishments is expected to be higher than with the number of hotels, motels and pensions.

H2 Correlation between the number of active rentals and the number of all accommodation establishments is higher than that between the number of active rentals and the number of hotels, motels and pensions across counties in Poland.

Tourism attractiveness

Visiting tourism attractions is traditionally the main motive for travelling, so the relationship between the emergence of sharing economy providers should be expected within areas of their intensity. Tourism attractiveness is, however, a complex and ambiguous term that is difficult to measure. It is either measured from a demand-side (in this way number of tourists or a survey among tourists are signs of tourism attractiveness) (Ritchie & Zins, 1978), both demand and supply (Formica & Uysal, 2006) and solely from supply-side (Milewski, 2004). As motives are very different starting from a basic distinction between leisure and business, any tourism attractiveness index is a weighted average of different approaches as, e.g. tourism attrac-

tiveness can be enhanced by development of a new transportation connection (Masson & Petiot, 2009), preservation of natural sceneries (Lee et al., 2010) or even a crime reduction (Altindag, 2014).

The relationship between the location of tourist attractions and the location of hospitality establishments might not always be correlated. Based on the study from Lisbon, Portugal, Cró & Martins (2018) point out that both accessibility to transport and proximity to tourist attractions are not crucial factors for the location of new hotels. Those findings were supported by the paucity of new land and safety of new districts, even if they are located away from nightlife attractions. Those results can be partly explained by business motives of hotel guests and, although Airbnb is aggressively pushing the business segment, still, a majority of their customers are leisure (Lutz & Newlands, 2018). Recent studies of participation motives in the sharing economy show that costs factors and social interaction play a major role (Guttentag et al., 2018; So, Oh & Min, 2018). The difference between the location of a traditional and a sharing economy accommodation establishments is also visible in the results of available research about various aspects of the spatial position of providers and their prices. Using a hedonic price model, price variations are explained by a variation of two main groups of variables: those linked to attributes of the supplier (e.g. the number of rooms, amenities, traits of standard, rating, etc.) and those linked to its location. The former includes the first and foremost distance to the city centre, transportation hub or even congress centre (e.g. Gutiérrez et al., 2017). In the case of sharing economy, the distance between tourist attraction and an accommodation establishment can explain the variation of prices (Deboosere et al., 2019; Dornier & Selmi, 2018; Napierała & Leśniewska, 2014) whereas those factors are hardly considered in hedonic models for traditional hospitality prices. Therefore:

H3a There is a strong positive relationship between the number of sharing economy active rentals and tourism attractiveness index across counties in Poland.

H3b Correlation between the number of active rentals and the cultural tourism attractiveness index is higher than the one between the number of active rentals and the business tourism attractiveness index.

Methodology

To conduct our analysis, data from two main data sources were used: AirDNA for sharing economy development and Statistics Poland (Official Polish Statistical Office) for remaining variables.

As data for sharing economy is not available in official statistics and sharing economy platforms themselves are not publishing any reliable numbers (Comp. Agarwal, Koch & McNab, 2019), it was necessary to be based on data provided by AirDNA, a company which business model is based on monitoring a website activity of two main sharing economy platforms in the accommodation sector (Airbnb and Homeaway) and selling aggregated or detailed data mostly to business in the accommodation sector. AirDNA uses a common freemium model, as they allow to access basic data publicly, whereas more detailed information is available only for paid premium users. It is also possible to purchase a specific set of information for a given region. The data derived from AirDNA are increasingly used in scientific research (Comp. Adamiak, 2018; Agarwal et al., 2019; Ayouba et al., 2019; Dogru & Pekin, 2015; Karakas, 2017). There are three ways in which AirDNA data is obtained: it is either scrapped using specific software (Deboosere et al., 2019), it is purchased (Agarwal et al., 2019; Ayouba et al., 2019), or, and this is the most popular due to simplicity and cost factor, manually collected (Karakas, 2017; Lane & Woodworth, 2016). The other problem of using AirDNA data is its constantly changing methodology: e.g. the main difference between previous studies and the present one is based on the inclusion of HomeAway as a second sharing economy platform apart from Airbnb in the second part of the year 2019.

The main advantage of using AirDNA data is the fact that they are aggregated at a NUTS-4 level which in Poland means data is available for 380 counties (in Polish – *powiat*). Out of those 380 counties in Poland, 66 are city counties which is vital from the goal of the study as those counties represent typical urban areas. Still, numbers are not available for every region as AirDNA does not provide data for regions where there is no sharing economy activity. Moreover, while collecting data, certain biases were also found, as for two regions only partial data was available (for example, in Tatrzanski region only data for one city – Zakopane was available). Furthermore, in Poland among 380 counties there are 10 pairs of counties with the same name and the data were available only for one of the counties from each pair. The missing data from those counties were collected manually from Airbnb and HomeAway websites.

There is a small discussion about the reliability of AirDNA data among scholars. Airbnb itself claims that this company simply monitors the activity of their website and as such, it must produce biased results due to the availability of expensive services which are never rented. A representative of Airbnb claims that AirDNA results overestimate the actual size of sharing economy and are frequently used by the hospitality industry as a rationale for the introduction of public regulation that limits this P2P market. In a similar

vein, research conducted in Virginia Beach (tourist city in the USA – population of ca. 430 thousand) showed that AirDNA metrics are biased. According to their study, AirDNA data from one side underestimates the actual size of sharing economy as they utilize only booked listings and, on the other side, it overestimates its profitability for the same reason. Moreover, the authors are of the opinion that AirDNA data cannot be compared to other hospitality measures produced, e.g. by STR, due to inconsistent methodology (Agarwal et al., 2019). Still, those reservations are irrelevant for the present research, where attention is given to spatial diversity of sharing economy and relative, not absolute, numbers are essential.

The second major source of information was Statistics Poland. From their resources data about population across counties, a number of hotel establishments and the total number of accommodation establishments were retrieved. Although the reliability of official statistics is increasingly questioned among practitioners and scholars due to the fact that the number of accommodation establishments operating without, e.g. official classification is on the rise in Poland, it is still considered to be the best source of hospitality market data. Also, data about tourism attractiveness of counties was derived from a special Statistics Poland report. Tourism attractiveness was a sum of cultural, natural and business attractiveness which was computed at the county level in 2014 (Foremska et al., 2015). Each of four coefficients (tourism, cultural, natural and business attractiveness) varies between 0 and 100 where 0 stands for no attractiveness and 100 for perfect attractiveness.

A correlation between variables is calculated using Spearman's rank correlation coefficient as available data does not meet the bivariate normal distribution condition to use Pearson coefficient. Moreover, sharing economy active rentals are concentrated in cities which implies that a few records would have extreme values that may affect Pearson coefficient. A Spearman's coefficient value over .8 will be considered as a very strong and the value between .6 and .79 a strong one.

Results

This study uses descriptive statistics to determine which factors influence the presence of sharing economy providers in the Polish accommodation market. Importantly and unlike previous research, the study includes not only areas where sharing economy flourishes, but also peripheral locations where it is in a nascent stage. Hence data for all 380 counties in Poland were collected in September 2019.

The data about active rentals were available for 274 out of 380 counties (72%). The total number of active rentals in Poland was 43 451 (out of which Warsaw – 7,8k, for a comparison, number of active rentals in three top sharing economy destinations: London – 73k, Paris – 47k, New York – 37k, Budapest – 12,6k, Prague – 13,1k, Kiev – 8,6k).

Warsaw and Krakow were the counties with the highest number of active rentals (7878 and 7424 respectively). The sharing economy accommodation market in Poland seems to be highly concentrated as the top 4 counties (i.e. 1% of all counties) account for 51% of all active rentals and top 10 for 68%. This is confirmed by the relation between mean and median value: median value is 16 active rentals while an average (mean) value is 116. Table 1 presents a general overview of the sharing economy in the Polish accommodation sector.

Table 1.   Active rentals in Poland

Total number of counties	380
Counties with >0 active rentals	274
Counties with >=10 active rentals	203
Counties with >=20 active rentals	123
Counties with >=40 active rentals	81
Counties with >=100 active rentals	39
Counties with >=200 active rentals	27
Total number of active rentals	44 128
Mean	116
Q1	9
Q2	16
Q3	50
Active rentals in top4 counties/all active rentals	51%
Active rentals in top10 counties/all active rentals	68%

Source: author's work.

The spatial distribution of active rentals is similar to the traditional hospitality market with the highest number in major metropolises, Baltic coast (North-West Poland) and mountains (southern part of Poland) (figure 1).
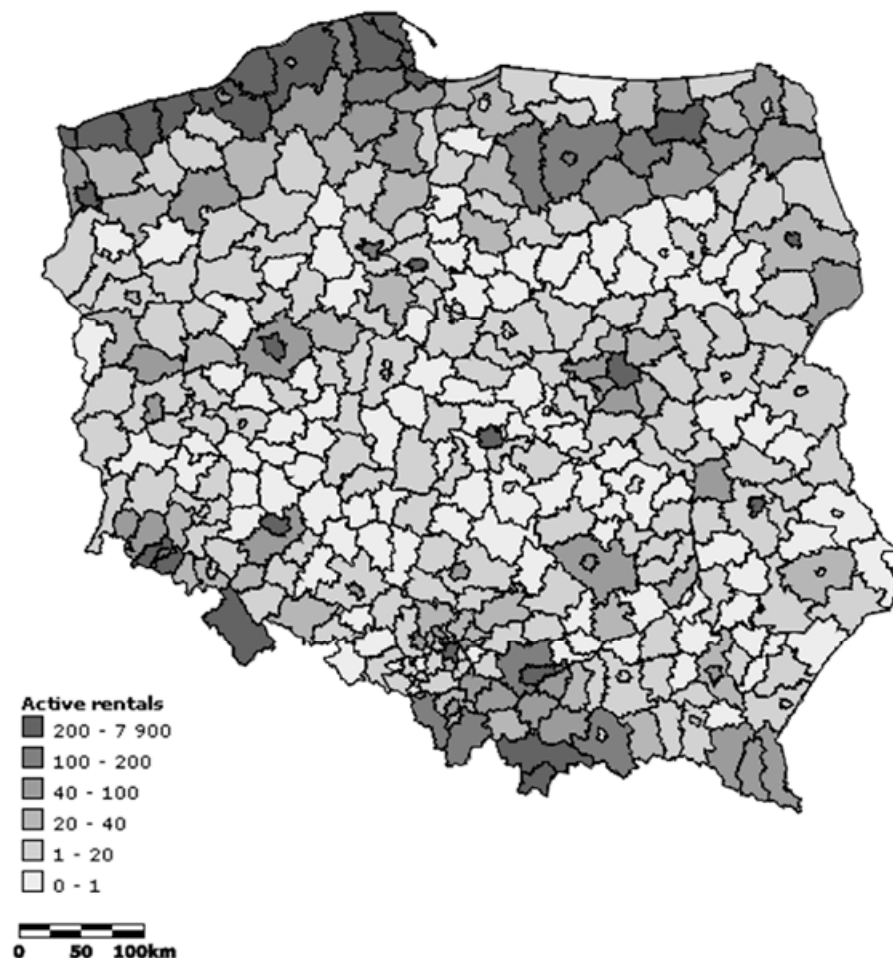
Figure 1. Active rentals on sharing economy in Polish accommodation market across counties

Source: authors' work based on Statistics Poland, 2019.

To show spacial clustering across Poland, a GIZ score was calculated for all counties (figure 2).

There are four major clusters: the first one in North Poland around the city of Gdańsk, the second one around the capital city of Warsaw, the third one across Krakow a major tourist destination and the fourth in the south in Zakopane which is a well-known mountain resort.
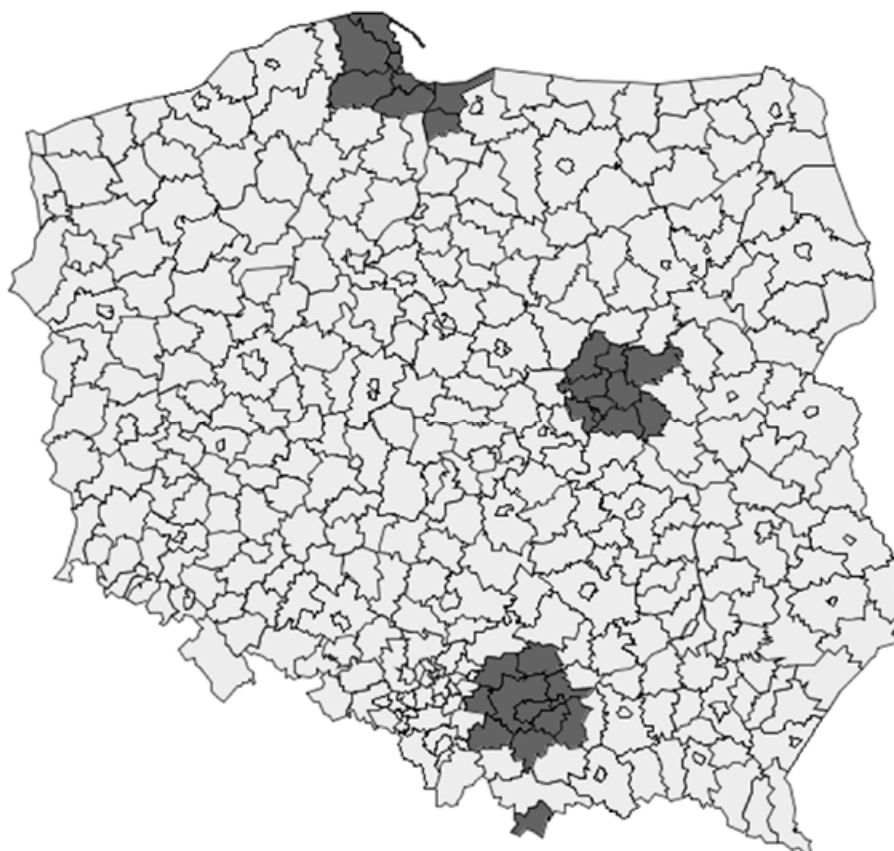
Figure 2. GIZ scores

Light coloured counties represent a score between <-1,64;1,64>, Dark coloured counties represent a score above 1,94.

Source: authors' work.

Population

A county population and the number of active rentals across counties are only moderately positively correlated (Spearman = .41). However, a strong positive correlation can be observed among top destinations, e.g. for top 10 sharing economy counties (i.e. for counties with top 10 values of active rentals Spearman is .77, which means a strong correlation. On the other hand, it is difficult to see any correlation between population and the number of active rentals among less populated counties where the sharing economy market is still not developed. Figure 3 presents a scatter graph showing the relationship between the number of active rentals and the population for

counties with a population under 200 000 and the number of active rentals less than 200 (which represents 343/380= 90% of all counties).
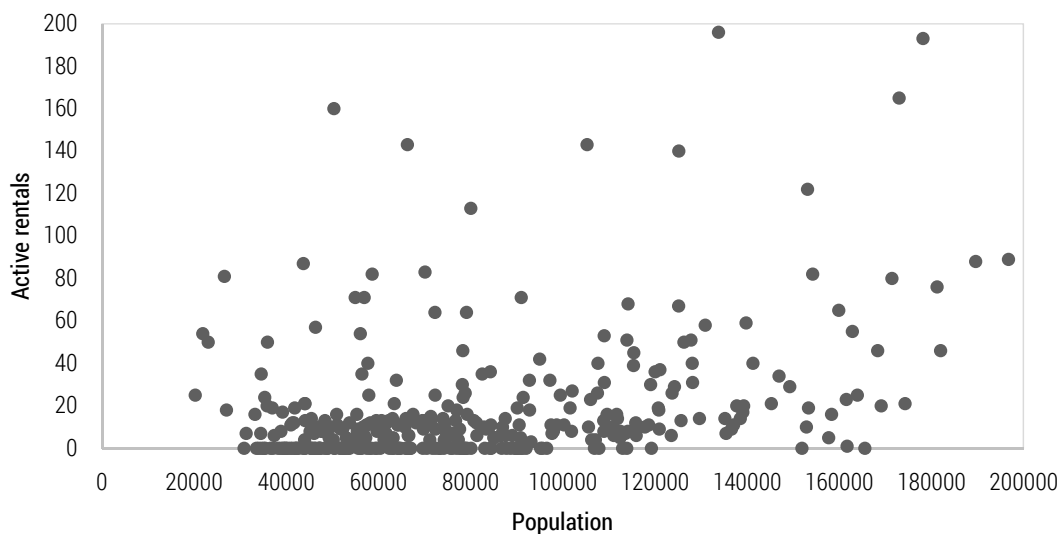
Figure 3. Relationship between population (X) and the number of active rentals (Y)

Source: author's work.

Figure 4. Relationship between the number of active rentals (X) and population density (pop. per km^2) (Y)

Source: author's work.

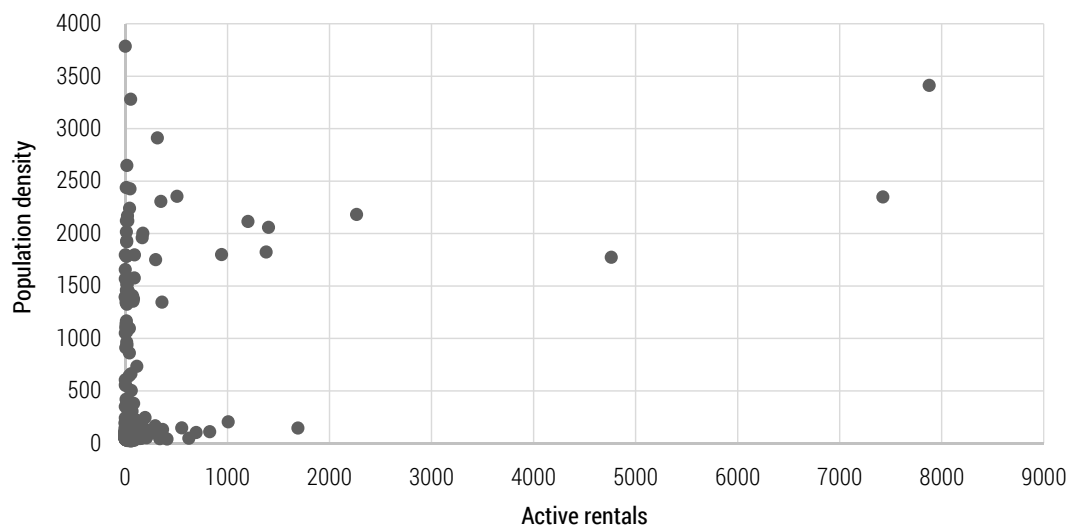Although sharing economy is widely considered as an urban phenomenon, there was no evidence that the population density and the number of active rentals are correlated (figure 4).

As it is expected from figure 3 Spearman coefficient shows almost no correlation between those two variables (Spearman = .23). The population density in Poland is, however, very diverse: a region with the highest population density is Silesia due to its industrial character whereas North and West (the Baltic Sea coast) regions are traditionally much less populated.

According to the result of an analysis presented in table 2 sharing economy is also in Poland a typical urban phenomenon as 72% of all active rentals in Poland are present in urban counties which represent 33% of the Polish population. So the number of average active rentals per 1000 inhabitants in urban counties is 5 times more than in non-urban counties.

Table 2.   Active rentals in urban versus non-urban areas

	Urban	Non-urban
Number of counties	66	314
Number of counties with >0 active rentals	57	217
%	86%	69%
Number of active rentals	31 668	12 460
% of all	72%	28%
Population	12 601 338	25 832 220
%	33%	67%
AR/1000inh	2,51	0,48

Source: author's work.

Sharing economy and traditional hospitality business

According to the Statistics Poland data, there is at least one hotel (or a motel or a pension) in 363 counties and at least one accommodation establishment in all but one county. All in all, there are 11 076 accommodation establishments in Poland out of which 3122 are classified as hotels, motels, and pensions. Both numbers of all accommodation establishments and a number of hotels, motels, and pensions are correlated to the number of active rentals. Spearman coefficient for all establishments is .74 while for hotels, motels and pensions .62, so hypothesis 2 has been supported.
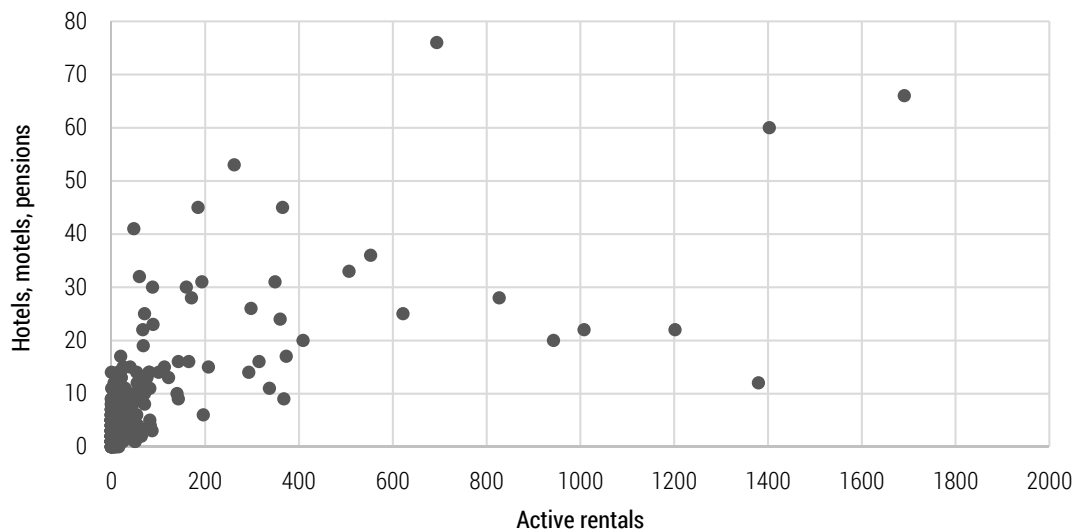
Figure 5. Correlation between the number of active rentals (X) and the number of hotels, motels and pensions (Y) across counties in Poland

Data for 376 counties with active rentals <2000 and number of hotels, motels, and pensions <80.
Source: author's work.
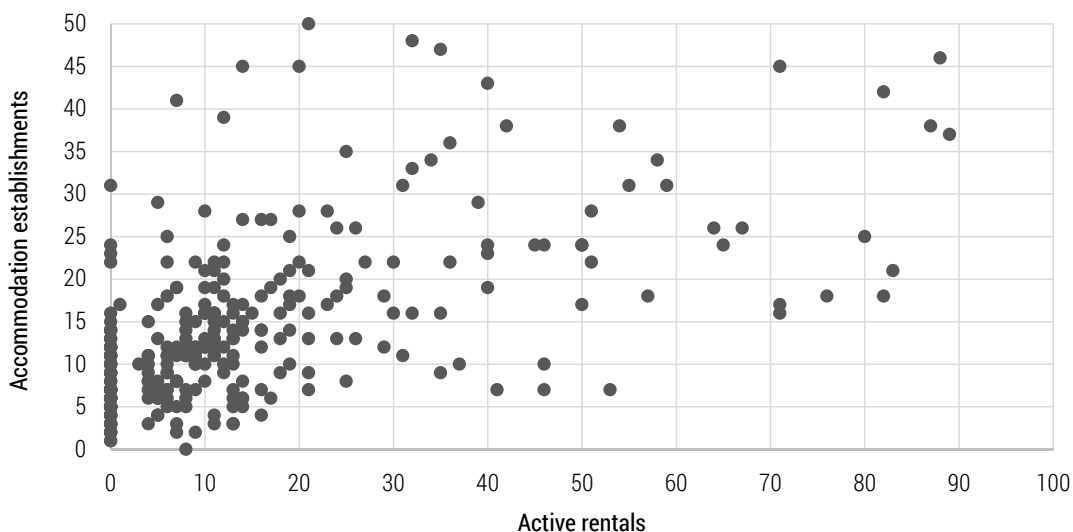
Figure 6. Correlation between the number of active rentals (X) and the number of all accommodation establishments (Y)

The data for 327 counties with the number of active rentals <100 and number of accommodation establishments <50.
Source: author's work.

Figures 5 and 6 suggest that providers on the sharing economy are much more concentrated than in the traditional market as there are more counties with no providers and more counties with exceptionally many. To measure concentration in those three populations Herfindahl-Hirschman Index (HH Index) was calculated. HH index is defined as the sum of the squares of the market shares of the organizations within the industry and ranges from 0 (equal distribution or perfect competition) to 1 (perfect monopoly). The results are shown in table 3.

Table 3. Herfindahl-Hirschman Indices

Active rentals	0,080
Hotels, motels, pensions	0,010
All accommodation establishemnts	0,013

Source: author's work.

As it can be seen from the table 3 sharing economy establishments are much more concentrated than a traditional hospitality base and, as it can be seen in the figures 4 and 5, its distribution is also correlated. From the country perspective, the emergence of sharing economy led to more concentration in the hospitality market. So the claim held by sharing economy platforms of diversifying spatial distribution of hospitality base is not justified at the country level.

Tourism attractiveness

Tourism attractiveness is measured using four Statistics Poland indices which basic statistics are depicted in table 4. Tourism attractiveness index is computed using the following formula:

$$TAI = 0,4 \cdot CAI + 0,4 \cdot EAI + 0,2 \cdot BAI. \tag{1}$$

Table 4. Tourism attractiveness indices for Polish counties

Index	Tourism attractiveness index	Cultural attractiveness index	Environmental attractiveness index	Business attractiveness index
Acronym	TAI	CAI	EAI	BAI
Mean	4,05	3,75	4,58	3,58
St. deviation	4,97	6,31	6,56	8,22
Max	50,65	74,90	38,98	100,00
Min	0,08	0,18	0,00	0,00

Source: Foremska et al., 2015.

The two most attractive Polish counties are Warsaw and Krakow, which are also the top sharing economy destinations. Figure 7 illustrates the spatial distribution of tourism attractiveness among Polish counties.
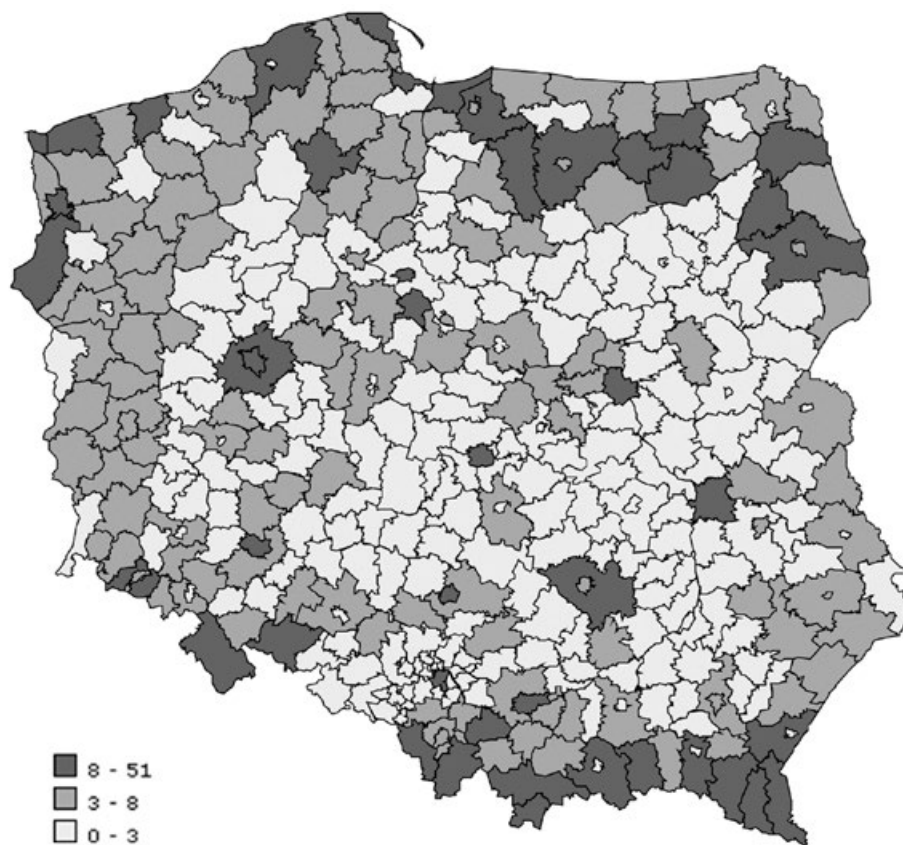
Figure 7. Tourism attractiveness across counties in Poland

Source: author's work based on Foremska et al., 2015.

The most attractive counties in Poland with a few exceptions are major cities, coastline (the West-North of Poland), mountains (the Southern border) and the great lakes (North-East). This, by large, resembles the spatial distribution of sharing economy providers depicted in figure 1. Spearman's correlation coefficient between the number of active rentals and tourism attractiveness index is positive and strong (.65).

All three other tourism attractiveness indices are also positively correlated with tourism attractiveness, however, surprisingly only business index was strongly correlated (.66) while cultural only moderately (.43) and environmental weak (.36).

The sharing economy is, therefore, an urban phenomenon as qualitative studies predicted. The number of active rentals is strongly correlated with the number of traditional accommodation establishments, particularly in the classified hospitality base area. The emergence of sharing economy providers is also correlated with tourism attractiveness (table 5).

Table 5. Results summary

Hypotheses	Result	Supported?
H1a There is a strong positive relationship between the number of sharing economy active rentals and population across counties in Poland	.41	No
H1b There is a strong positive relationship between the number of sharing economy active rentals and population density across counties in Poland	.23	No
H1c A number of sharing economy active rentals per 1000 inhabitants is higher in urban counties than in rural counties in Poland.	2.51 (urban) > 0.48 (non-urban)	Yes
H2 Correlation between the number of active rentals and the number of all accommodation establishments is higher than the one between the number of active rentals and the number of hotels, motels and pensions (HMP) across counties in Poland.	.74 (HMP) > .62 (all)	No
H3a There is a strong positive relationship between the number of sharing economy active rentals and tourism attractiveness index across counties in Poland	.65	Yes
H3b Correlation between the number of active rentals and the cultural tourism attractiveness (CTA) index is higher than the one between the number of active rentals and the business tourism attractiveness (BTA) index.	.43 (CTA) < .66 (BTA)	No

The correlation is calculated as Spearman's coefficient
Source: author's work.

Conclusions and limitations

Several significant findings emerged from this study for future theoretical development efforts in the sharing economy literature. Firstly, based on the previous research studies, a set of potential factors influencing the spatial distribution of sharing economy providers has been built. Sharing economy flourishes in urban areas, and its development is correlated with tourism attractiveness. Other hypotheses, however, were not supported. Still, correlations are much more visible in areas where sharing economy is developed, i.e. when calculations are made only for counties where sharing economy is developed (which supports the findings of Martín et al., 2019).

In evaluating the significant findings from this study, several limitations need to be acknowledged. Firstly, in assessing the size of sharing economy in

the Polish accommodation market, a number of active rentals were used. Alternatively, a number of rooms or places could be used. In case of sharing economy where each room (even in hospitality businesses using sharing economy platforms as a distribution channel) is marketed independently on platforms, this should not produce different results, but certain differences might be observed when analysing data for traditional hospitality business where an average number of rooms and beds across various establishments can vary over space. This shortcoming should be addressed by future research.

Similar considerations should be given to the fact that traditional hotels may use the sharing economy platforms as another way to market their products. Although most of them are independent boutique hotels, B&Bs, and hostels which, according to previous qualitative research are either not included in the official register or constitute just a fraction of supply available through sharing economy platforms, there is no quantitative research in these areas, which is an obvious research gap which need to be amended by future research.

Finally, this study uses data from Poland, and the results cannot be generalized to other regions. The future research could be based on data from other countries which may be different in terms of attractiveness, the structure of the hospitality market, etc. This research is based mostly on data derived from Statistics Poland, which, especially in terms of measuring attractiveness and classifying hospitality market, are specific for Poland, which does not render any direct comparison of results.

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The contribution of the authors

Adam Pawlicz – 50% (concept and objectives, research, reviewed the final manuscript).
Ana-Marija Vrtodusic Hrgovic – 50% (concept and objectives, literature review, reviewed the final manuscript).

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ECONOMIC EFFECTS OF CHANGES IN THE REQUIRED THERMAL INSULATION OF BUILDING PARTITIONS IN POLAND

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ABSTRACT: Thermal insulation on the external partitions of the buildings is a very usual strategy to reduce energy demand for heating. This paper presents an original study of the demand for usable energy $Q_{H,nd}$ of a single-family residential building in different climatic conditions (milder conditions – Szczecin, national average – Lodz and more severe conditions – Zakopane) on the thermal transmittance coefficient of selected partitions: external walls, roof, windows and balcony doors, roof windows and doors. They were adopted at three levels, corresponding to the maximum required values, as approved in the Technical Conditions, for periods from 2014, 2017 and 31.12.2020. Based on the results of the computational experiment, three deterministic mathematical models were developed, and the effects of factors on the Y function for the assumed climate conditions were analyzed. Financial savings related to the introduction of stricter requirements for thermal protection of buildings in Poland were determined.

KEY WORDS: demand for usable energy, climate conditions, thermal transmittance coefficient of building partitions, deterministic mathematical model, the economic effect

Introduction

The beginnings of the normalization process for thermal protection of buildings in Poland are connected with the publication by the Publishing House of the Ministry of Reconstruction from 1947 titled "Thermal tables of building structures" (Pogorzelski, 1999). In this document, the thermal conductivity values of the building materials coefficient used for calculating heat transfer coefficients of partitions, as well as the required power of heating devices were included. Then, the PN-57/B-02405 standard provides tabulated U-values of frequently used baffles, mainly for heating purposes. The required maximum U-values for opaque partitions were introduced in 1968 (PN-B-03404: 1964), due to the requirement of avoiding the water vapour condensation on internal surfaces and based on experience in traditional construction. For walls, this value was 1.47 W/(m²K) in the first and second climate zones of Poland and 1.16 W/(m²K) in the remaining zones (III, IV and V). It corresponded to the specified thickness of the brick wall (two brick wall or one and a half brick wall). The requirement for roofs U_{max} of 0.87 W/(m²K) was supposed to eliminate the risk of snow melting on the roof. In 1982, the PN-/B-02020 standard reduced the required U-value of walls to the level of 0.75 W/(m²K) and of roofs to 0.45 W/(m²K), and the requirements were differentiated due to climatic zones. In 1991 U_{max} was reduced for walls to the level of 0.55 W/(m²K) and to 0.30 W/(m²K) for roofs. The number of building parameters regulated by standards, related to the reduction of heat losses (including requirements for windows, heat exchange with the ground, limitation of glass surfaces or air infiltration coefficient) also began to increase.

In 1997, the requirements for thermal protection of buildings were moved from the standards to "Technical conditions that should be met by buildings and their location". In the case of public and industrial buildings, the requirements still concerned the heat transfer coefficient of partitions (U_{max}=0.30-0.50 W/(m²K)). For multi-family residential buildings and collective residences, the limit value of the seasonal heating demand for heating in the standard heating season E_o was determined. In the group of single-family houses, the alternative requirement of U_{max} or E_o was in force.

In November 2008, as part of the implementation of the provisions of Directive 2002/91/EC on the energy performance of buildings (EPBD), the Technical Conditions were amended, and an alternative requirement for the maximum value of thermal transmittance coefficient was set for all buildings (U_{max} = 0.30 W/(m²K) for walls and 0.25 W/(m²K) for roofs) or indicator of non-renewable primary energy (EP). In another amendment of the Polish regulation of 2013 (PL, 2013), both thermal protection requirements for new buildings ($U \leq U_{max}$ and $EP \leq EP_{max}$) have become obligatory. The maximum

values of thermal transmittance coefficient of selected partitions with their validity periods are presented in table 1.

Table 1.　Values of thermal transmittance coefficient $U_{C(max)}$ of selected partitions at room temperature $t_i \geq 16°C$ in Poland

Type of partition	Thermal transmittance coefficient $U_{C(max)}$, W/(m²K), since:		
	01.01.2014	01.01.2017	31.12.2020
External walls	0.25	0.23	0.20
Roofs and ceilings above unheated attic	0.20	0.18	0.15
Windows and balcony doors	1.30	1.10	0.90
Roof windows	1.50	1.30	1.10
Doors	1.70	1.50	1.30

Source: author's work based on PL, 2013.

Issues of choosing the appropriate thickness of thermal insulation in partitions or the optimal thermal transmittance coefficient have been described in many papers (Bogusławski, 1969; Górzyński, 1995; Laskowski, 2005; Pogorzelski, 1998; Robakiewicz, 1998; Rudczyk-Malijewska, 1999; Sanecki, Skoczek, 1966; Stachniewicz, 2002). In the article (Rudczyk-Malijewska, 1999), the practical inability of static methods of thermal insulation of buildings is shown, due to the fact that economic criteria are not included in them.

Although the EBPD Directive imposed the obligation that the minimum energy performance requirements determined by individual European countries should be cost-optimal, it is clear from the report prepared by ECOFYS for EURIMA (ECOFYS, 2007) that threshold U-values for individual building elements (roof, floor, walls, windows, etc.) initially did not always coincide with the economic criterion and did not always achieve specific environmental objectives. The optimal U-values recommended in (EURIMA, 2007) resulting from the analysis based on cost-effectiveness and POST-Kyoto goals (reduction of CO_2 emissions by 85% by 2050) were in most cases more ambitious than national requirements. These differences depended on the country and the components of the building under consideration. At present, the optimal thickness of thermal insulation for buildings in various climates is increasingly assessed using "cost-optimal" methods (D'Agostinoc et al., 2019; Tzuolisa et al., 2017) or "investment saving" method (PL, 2015).

The problem of optimizing the insulation level of building partitions in heated buildings has been in the scope of Authors' scientific interest since 2016. In the article "Optimal thickness of thermal insulation layer of external

walls in current economic conditions" (Jezierski et al., 2016) on the basis of simulation results, the Authors presented optimal thermal insulation layer thickness for external walls in residential buildings with various heating sources and for various macro- and microeconomic parameters (such as the discount rate, VAT tax, as well as unit heat energy prices and thermal insulation costs). The analysis showed that regarding the optimal values of thermal transmittance coefficient U_{opt} for conditions from 2016, tightening the requirements of thermal protection by introducing new reduced U_{max} should not be considered radical. The stricter requirements regarding U_{max} (from 2017 and 31.12.2020), amounting to 0.23 W/(m²K) and 0.20 W/(m²K), respectively, introduced by Polish legal regulations, do not exceed the U_{opt} reduction, calculated using the dynamic method (NPV) when heating the building from the heating network or using electricity; on the contrary, they are almost twice as large as U_{opt}.

However, there are questions – what gives in the real operating conditions of buildings a reduction of the U_{max} requirements by 0.03 W/(m²K) introduced in two subsequent periods of time? Have U_{max} changes for partitions been too slow in recent years? Unfortunately, in the scientific literature, there are no results available for the estimation of energy and economic effects from U_{max} changes for all these divisions. This is an important issue determining the final energy balance of the entire building; hence it should be considered.

Considering the permissible values of the heat transfer coefficient of building partitions in heated buildings set for subsequent periods, one could admit that their implementation will evenly reduce the heat demand for heating for all buildings, as well as for all their locations, despite the fact that they significantly differ in climate conditions. Unfortunately, there is no data on this subject in recent publications. As in the case of U-value, the required by Polish law levels of energy demand are not dependent on climate zones. Such a diversification appeared only in the first version of the program of subsidies for energy-efficient buildings (NECA, 2012) and was removed in the later drafts.

In connection with the above, the aim of this work is to examine the annual demand for usable energy for heating and ventilation $Q_{H,\mathrm{nd}}$ a selected single-family house in different climatic conditions: milder (Szczecin), medium-sized (Lodz) and more severe (Zakopane). The analyzed demand depends on the thermal transmittance coefficient of external walls (U_1), roof (U_2), balcony windows and doors (U_3), roof windows (U_4) and external doors (U_5), adopted at three levels corresponding to the maximum permissible values, as approved in the Technical Conditions for periods from 2014; 2017 and 31.12.2020. The Authors also set out to develop three deterministic mathe-

matical models of this relationship with the estimation of these factors and their effects in different climatic conditions.

Description of the investigated house

The analysis was conducted on a single-family, one-level house, without a basement, with a heated attic and a simple architecture referring to the traditional style. Its usable area is 150,11 m² and cubature about 690 m³. In the plan, the building has a rectangular shape with dimensions of 9.54 m and 11.04 m. It is made in traditional technology, with a gable roof covered with ceramic tiles. The entrance façade is oriented from the north. The schematic diagram of the tested building is shown in figure 1.
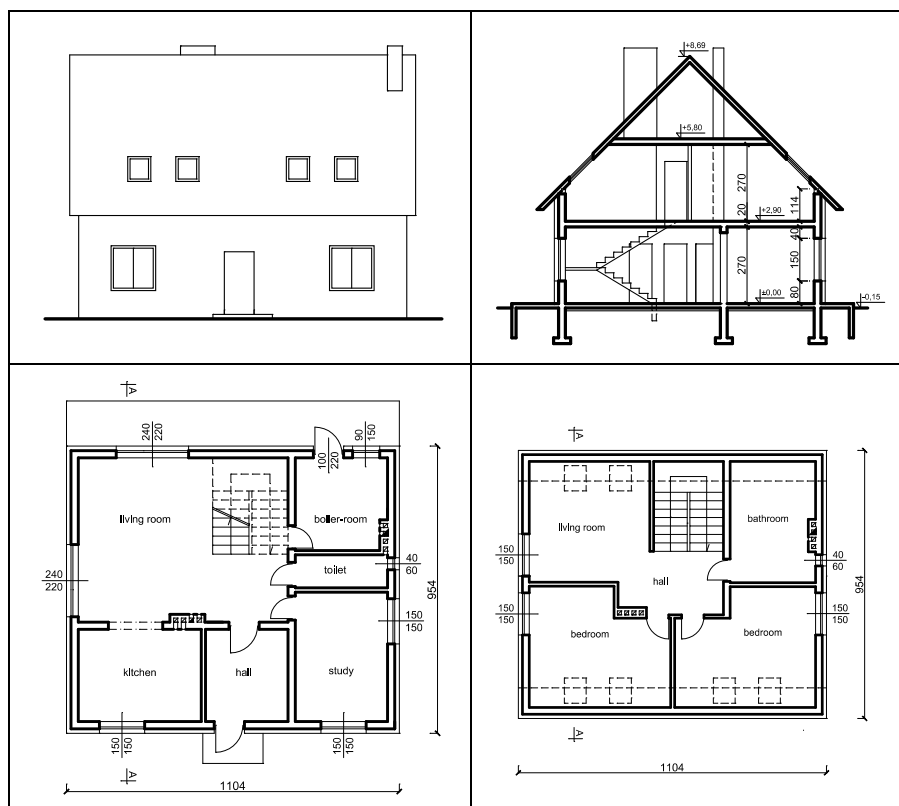
Figure 1. Scheme of the tested single-family house: A – front elevation; B – vertical section; C – ground floor plan; D –plan of a heated attic

Source: author's work.

The house's walls were made of cellular concrete and foamed polystyrene. The insulation of the roof was mineral wool and gypsum board on the attic side. The floor on the ground consists of a concrete foundation on gravel ballast, 10 cm thick foamed polystyrene, PE film and floor layers on a concrete foundation. Windows and external doors are made of PVC. Ventilation is natural. A natural gas boiler, panel radiators located under windows with thermostatic valves, central and local regulation, pipes with good insulation located in heated rooms are used in building.

The method of usable energy demand calculation

The usable energy demand for space heating and ventilation $Q_{H,nd}$ [kWh/year] describes the energy balance of a building, taking into account heat gains and losses in an annual period. The calculation of $Q_{H,nd}$ of the selected building was carried out according to the methodology (PL, 2015) in force in Poland from 27.02.2015. It is the sum of the $Q_{H,nd,s,n}$ demand for each of the heated zones in the building and for each of the months of the year and is determined according to formulas (PL, 2015):

$$Q_{H,nd,s,n} = Q_{H,ht,s,n} - \eta_{H,gn,s,n} \cdot Q_{H,gn,s,n}, \tag{1}$$

$$Q_{H,ht,s,n} = Q_{tr,s,n} + Q_{ve,s,n}, \tag{2}$$

$$Q_{tr,s,n} = H_{tr,s} (\theta_{int,s,H} - \theta_{e,n}) \, t_m \, 10^{-3}, \tag{3}$$

$$Q_{v,e,s,n} = H_{ve,s} (\theta_{int,s,H} - \theta_{e,n}) \, t_m \, 10^{-3}, \tag{4}$$

$$H_{tr,s} = \sum [b_{tr,i}(A_i U_i + \sum l_i \Psi_i)], \tag{5}$$

$$H_{ve,s} = \rho_a \, c_a \sum_{I,k} V_{ve,k,n}, \tag{6}$$

$$Q_{H,gn,s,n} = Q_{sol,H} + Q_{int,H}, \tag{7}$$

$$Q_{sol,H} = \sum C_i A_{oi} \, I_i \, F_{sh,gl} \, F_{sh} \, g_{gl}, \tag{8}$$

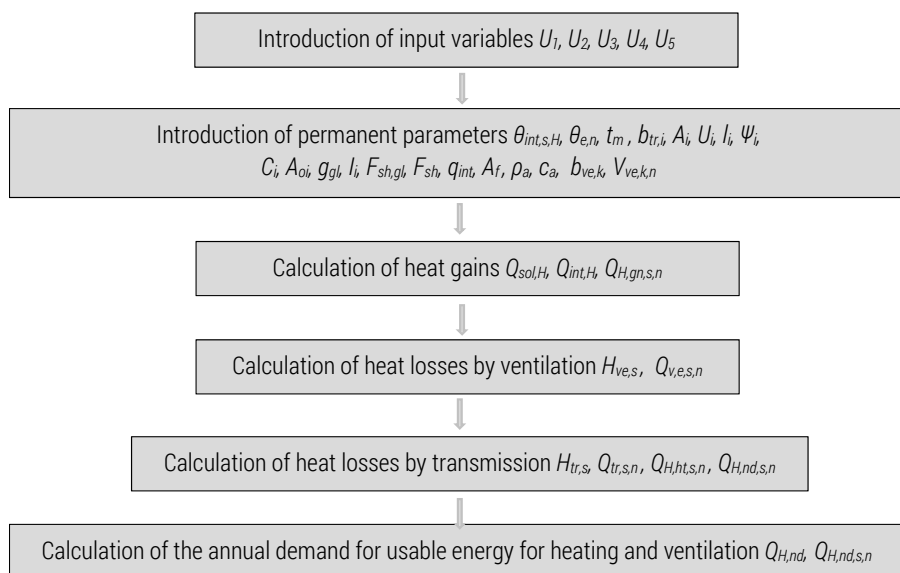$$Q_{int,H} = q_{int} A_f \, t_m \, 10^{-3}, \tag{9}$$

where:
A_f – the useful floor area,
A_i – the area of element I of the building envelope,
A_{oi} – the surface area of window or door opening,
$b_{tr,i}$ – the reduction factor for the adjacent unconditioned space,
C_i – share a glass plane surface area to the total area of the window,
F_{sh} – reducing factor due to shading from the external partitions,

$F_{sh,gl}$ –   shading reduction factor for movable shading devices,
g_{gl} –   the total solar energy transmittance factor of the transparent part of the element,
q_{int} –   internal heat sources,
$H_{ve,s}$ –   the total heat transfer coefficient by ventilation of the building or building zone s,
$H_{tr,s}$ –   the total heat transfer coefficient by the transmission of the building or building zone s,
I_i –   the value of solar energy in the considered month on the plane in which there is a window,
$I_{,k}$ –   the reduction factor for the adjacent unconditioned space,
l_i –   the length of linear thermal bridge k,
$Q_{H,gn,s,n}$ – the total heat sources in the heated zone s in the n-th month of the year,
$Q_{H,ht,s,n}$ – the total heat transfer from the heated zone s in the n-th month of the year,
$Q_{int,H}$ –   the sum of internal heat sources,
$Q_{sol,H}$ –   the sum of solar heat sources from solar radiation through windows or door opening,
$Q_{tr,s,n}$ –   the total heat transfer by transmission from the heated zone s in the n-th month of the year,
$Q_{v,e,s,n}$ –   the total heat transfer by ventilation from the heated zone s in the n-th month of the year,
t_m –   the number of hours in a month,
U_i –   the thermal transmittance of element I of the building envelope,
$V_{ve,k,n}$ –   the airflow rate through the heated space,
$\eta_{H,gn,s,n}$ – the dimensionless gain utilization factor in the heated zone s in the n-th month of the year,
$\theta_{e,n}$ –   the average external temperature,
$\theta_{int,s,H}$ – the average internal temperature of the heated building zone,
$\rho_a \, c_a$ –   the heat capacity of air per volume,
Ψ_i –   the linear thermal transmittance of linear thermal bridge k.

Based on the presented formulas (1) – (9) and methodology (Pl, 2015), the Authors selected five input variables and developed an algorithm for calculating the demand for usable energy (figure 2) when changing the values of selected factors according to the plan of the computational experiment. This algorithm was the basis for developing an original computer program in Microsoft Excel.

It was assumed that the determination of the annual demand for usable energy for heating and ventilation $Q_{H,nd}$ of the analyzed building would be carried out successively taking into account the climatic conditions for each of the adopted building locations.

Introduction of input variables U_1, U_2, U_3, U_4, U_5

Introduction of permanent parameters $\theta_{int,s,H}$, $\theta_{e,n}$, t_m, $b_{tr,i}$, A_i, U_i, l_i, Ψ_i, C_i, A_{oi}, g_{gl}, I_i, $F_{sh,gl}$, F_{sh}, q_{int}, A_f, ρ_a, c_a, $b_{ve,k}$, $V_{ve,k,n}$

Calculation of heat gains $Q_{sol,H}$, $Q_{int,H}$, $Q_{H,gn,s,n}$

Calculation of heat losses by ventilation $H_{ve,s}$, $Q_{v,e,s,n}$

Calculation of heat losses by transmission $H_{tr,s}$, $Q_{tr,s,n}$, $Q_{H,ht,s,n}$, $Q_{H,nd,s,n}$

Calculation of the annual demand for usable energy for heating and ventilation $Q_{H,nd}$, $Q_{H,nd,s,n}$

Figure 2. Block diagram for calculating the annual demand for usable energy for heating and ventilation of a selected building

Source: author's own work based on PL, 2015.

Mathematical model of the usable energy demand of a selected residential building

As a research method, mathematical modelling was used, which allows mathematical dependencies to describe the functioning of the tested object, determine the output parameters and the optimal values of the input parameters of the object (Gutenbaum, 2003). The use of mathematical modelling allows to abandon physical modelling, minimize the number of sampling, and reduce the labor intensity of the study. The main component in such a system is the mathematical model.

Mathematical models are appropriate and effective tools to perform the analysis of a test object provided that the developed formulas are short and use the most important factors describing the process or property being investigated, and they are important for recipients of information about the tested object (Gutenbaum, 2003).

In the test, the annual demand for usable energy for heating and ventilation of the tested building $Q_{H,nd}$ was chosen as a function Y, depending on the following thermal transmittance coefficients: of external walls U_1 (factor X_1), roof U_2 (factor X_2), windows and balcony doors U_3 (factor X_3), roof windows U_4 (factor X_4) and external doors U_5 (factor X_5). The demand for usable energy for heating and ventilation of the building has a physical meaning, it is measurable and unambiguous. The selected factors result from the purpose of the study. They are measurable, controllable, independent, unambiguous and consistent, that is, they meet the basic requirements of mathematical modelling (Gutenbaum, 2003).

Table 2. Averaged climate characteristics for the heating season in selected cities in Poland

Group of climatic conditions	City	The energy of solar radiation on the plane with the window S orientation ΣI_i, kWh/(m^2 month)	The average monthly external temperature θ_e, ºC	The sum of hours of the heating season Σt_m, h
I	Szczecin	48188.5	4.49	5808
II	Lodz	46763.7	2.70	5328
III	Zakopane	63734.3	1.99	6048

Source: author's work based on PL, 2008.

Unfortunately, the factor of climatic conditions mentioned in the study was not taken into account as the sixth factor in the model, because it is presented with a set of various climate indicators (table 2), which are difficult to combine with a comprehensive indicator. Therefore, a decision was made to develop and compare three mathematical models of the dependence on five factors for each of the three groups of climatic conditions: for Szczecin (I) – $Q_{I,H,nd}$ ($Y_{I,i}$); Lodz (II) – $Q_{II,H,nd}$ ($Y_{II,i}$) and Zakopane (III) – $Q_{III,H,nd}$ ($Y_{III,i}$).

It was assumed that the desired dependency $Y = f(X_1, X_2, X_3, X_4, X_5)$ could be described by the second-degree polynomial in the form:

$$Y=a_0 +a_1X_1+a_2X_2+a_3X_3+a_4X_4+a_5X_5+a_{12}X_1X_2+a_{13}X_1X_3+a_{14}X_1X_4+a_{15}X_1X_5+$$
$$a_{23}X_2X_3+a_{24}X_2X_4+a_{25}X_2X_5+a_{34}X_3X_4+a_{35}X_3X_5+a_{45}X_4X_5+a_{11}X_1^2$$
$$+a_{22}X_2^2+a_{33}X_3^2+a_{44}X_4^2+a_{55}X_5^2 \qquad (10)$$

To obtain data for the description of this dependency, a 5-factorial calculation experiment was carried out according to the second-degree plan (table 4). A compositional symmetrical three-level plan, consisting of 26 trials (Korzyń-

ski, 2006) was applied. For the calculation of Y_i value in 26 lines of the plan, the author's program developed in Microsoft Excel was used.

The ranges of variability, according to the adopted objective of the study, for each of the considered factors have been adopted three levels corresponding to the maximum values specified in Polish regulations in force from 2014, 2017 and 31.12.2020 (table 1). For factors X_1 and X_2 this range turned out to be narrow and was only 0.03 W/(m²K). The larger range was for the remaining factors (0.2 W/(m²K)). Nevertheless, U_i values were chosen, approved in the Technical Conditions that buildings and their location should satisfy for the above-mentioned time periods. These ranges of the variability of factors allowed the Authors to check the sensitivity of the examined function and obtain useful information for those who are working on the regulations regarding the value of the U_{imax} coefficients tested before approving the thermal protection requirements of buildings for a new time period.

Thus, selected factors were adopted at levels (table 3): X_1: 0.20(-1), 0.23(0), 0.26(+1); X_2: 0.15(-1), 0.18(0), 0.21(+1); X_3: 0.90(-1), 1.10(0), 1.30(+1); X_4: 1.10(-1), 1.30(0), 1.50(+1) and X_5: 1.30(-1), 1.50(0), 1.70 W/(m²K) (+1). The principle of experimental planning regarding the symmetrical ranges of variability for all factors forced the Authors to deviate from the maximum values according to the Technical Conditions of 0.25 ($X_1 = +0.6667$) and 0.20 ($X_2 = +0.6667$ W/(m²K)) and change them at 0.26 and 0.21 W/(m²K) respectively. However, this did not pose any problem with modeling, because the new increased range covers previous values.

Table 3. Natural and standardized values of selected factors

factor level $\dot{X}_i$	U_1, W/(m²K) (X_1)	U_2, W/(m²K) (X_2)	U_3, W/(m²K) (X_3)	U_4, W/(m²K) (X_4)	U_5, W/(m²K) (X_5)
bottom (-1)	0.20	0.15	0.90	1.10	1.30
meddle (0)	0.23	0.18	1.10	1.30	1.50
upper (+1)	0.26	0.21	1.30	1.50	1.70
range of factor change ΔX_i	0.03	0.03	0.20	0.20	0.20

Source: author's work.

The above-mentioned natural values of factors $\dot{X}_1$, $\dot{X}_2$, $\dot{X}_3$, $\dot{X}_4$, $\dot{X}_5$ and the corresponding standardized values (in brackets) of normed values X_1, X_2, X_3, X_4, X_5 are presented in table 3. The transition from natural $\dot{X}_i$ to normative values X_i (Korzyński, 2006) is expressed by the following formula:

$$X_i = \frac{\dot{X}_i - \frac{\dot{X}_{i,max} + \dot{X}_{i,min}}{2}}{\frac{\dot{X}_{i,max} - \dot{X}_{i,min}}{2}}, \tag{11}$$

where:
$\dot{X}_i$, $\dot{X}_{i,max}$, $\dot{X}_{i,min}$ – are the current, maximum and minimum natural values of the i-th factor, respectively.

Table 4. Planning matrix and calculation results of $Q_{I,H,nd}$ ($Y_{I,i}$), $Q_{II,H,nd}$ ($Y_{II,i}$), $Q_{III,H,nd}$ ($Y_{III,i}$).

No	U_1 X_1	U_2 X_2	U_3 X_3	U_4 X_4	U_5 X_5	$Q_{I,H,nd}$ [kWh] $Y_{I,i}$	$Q_{II,H,nd}$ [kWh] $Y_{II,i}$	$Q_{III,H,nd}$ [kWh] $Y_{III,i}$
1	0.20 -1	0.15 -1	0.90 -1	1.10 -1	1.70 +1	6490	7204	8645
…	…	…	…	…	…	…	…	…
26	0.23 0	0.18 0	1.10 0	1.30 0	1.70 +1	7627	8418	10109

Source: author's work.

Based on the results of $Q_{I,H,nd}$, $Q_{II,H,nd}$, $Q_{III,H,nd}$ calculations (table 4), using the method of least squares (Durakovic, 2017), three mathematical models were developed in the form of regression equations for the dependence of $Y=f(X_1,X_2,X_3,X_4,X_5)$:

for Szczecin:

$$\hat{Y}_I = 7558{,}15 + 403{,}00X_1 + 274{,}88X_2 + 381{,}11X_3 + 90{,}78X_4 +$$
$$68{,}89X_5 + 2{,}25X_1X_2 + 3{,}25X_1X_3 + 2{,}13X_2X_3 + 1{,}84X_1^2 + 1{,}84X_3^2 \tag{12}$$

for Lodz:

$$\hat{Y}_{II} = 8343{,}84 + 430{,}38X_1 + 293{,}38X_2 + 405{,}72X_3 + 96{,}56X_4 +$$
$$73{,}44X_5 + 2{,}38X_1X_2 + 3{,}25X_1X_3 + 2{,}25X_2X_3 + 1{,}66X_1^2 + 1{,}66X_3^2 \tag{13}$$

for Zakopane:

$$\hat{Y}_{III} = 10020{,}03 + 520{,}11X_1 + 354{,}61X_2 + 490{,}16X_3 + 116{,}50X_4 +$$
$$88{,}89X_5 + 3{,}00X_1X_2 + 4{,}50X_1X_3 + 3{,}00X_2X_3 + 1{,}88X_1^2 + 2{,}38X_3^2 \tag{14}$$

Deterministic models are characterized by mutually unambiguous compatibility between the external interaction and the reaction to this impact. It was taken into account when testing the adequacy of models. Only one experiment was performed at each point of the plan. Then, in the absence of repetition and variance of measurement inaccuracies, the adequacy of the obtained equation according to (Durakovic, 2017) can be assessed by comparing the variances of the mean S^2_y and the residual variance S^2_r calculated according to the formulas:

$$S^2_y = \Sigma(Y_i - \bar{Y})^2/(N-1), \tag{15}$$

$$S^2_r = \Sigma(\hat{Y}_i - Y_i)^2/(N-N_b), \tag{16}$$

where:
N –   number of calculations,
N_b –   number of coefficients in the regression equation.

The Fischer criterion was applied for testing, which shows the reduction in spread with respect to the regression equation compared to the average spread (Durakovic, 2017):

$$F = S^2_y(f_1)/ S^2_r(f_2), \tag{17}$$

where:
f_1, f_2 –   the number of degrees of freedom,
$f_1 = (N-1)=26-1=25; f_2 = (N-N_b)=26-21=5.$

The regression equation describes the results of calculations adequately if the value of F is much greater than the tabular value F_t at the level of significance p and degrees of freedom f_1 and f_2.

As it results from calculations, for the developed model (12): F_I=285283,8738/0,0389=7333801,383; for the model (13): F_{II}=292547,6643/0,2611=1 120442,989; and for the model (14): F_{III}=473794,3215/0,0667 = 7106914,824. The tabular value $F_t = F_{0,05; 25;5} = 4,525$ (Durakovic, 2017). Thus, F_I, F_{II}, F_{III} values significantly exceed F_t, which means that the models are adequate. Their high quality also confirms the coefficient of determination at the level of $R^2 = 0.9998$-0.9999.

The significance of coefficients in equations (12) – (14) was also checked. Testing was performed using the t-criterion. Because at each point of the plan we have one result without repeats, the approach described in (Durakovic, 2017) was used, according to which for each coefficient was calculated $t_j = |b_j| /S_{bj}$, where b_j – values of coefficients of the regression equation; S_{bj} – standard

deviation of the j-th coefficient. To determine S_{bj}, the residual variance S_r^2 was used based on the sum of squared deviations $(\hat{Y}_i - Y_i)^2$. The values were compared with the critical value of $t_{0,05;5}$=2,02 (Durakovic, 2017). If $t_j < t_{0,05;5}$, the coefficient was considered irrelevant. After the removal of nine irrelevant factors, the final form of equations (12) – (14) with $k+1$=12 coefficients were adopted. After testing and analyzing the results, the models were considered useful for further analysis.

Analysis of the studied dependence based on a mathematical model

The analysis of the impact of the considered factors on the annual demand for usable energy for heating and ventilation of the selected building was made on mathematical models (12) – (14). In order to ensure better clarity, the discussion of results will be made on natural variables. As the minimum U_i values were adopted as the lower levels of factors (which will be in force in Poland from 1 December 2020), the interpretation had to be performed "backwards" of time.

Analyzing the developed models, it was found that in the centre of multifactorial space G_p, which is characterized by U_i values, corresponding to the current requirements for thermal protection of partitions in Poland (from 1/01/2017), namely: U_1=0.23 W/(m^{2}K); U_2=0.18 W/(m^{2}K); U_3=1.10 W/(m^{2}K); U_4=1.30 W/(m^{2}K) and U_5=1.50 W/(m^{2}K), the building's energy demand for selected groups of climatic conditions is: for Szczecin (1st group) $Q_{I,H,nd}$ =7558.15; for Lodz (II group) $Q_{II,H,nd}$ =8343.84 and for Zakopane (III group) $Q_{II,H,nd}$ =8343.84 kWh/year.

As confirmed by the results of the calculations, the energy demand of the same building varies considerably depending on the location, namely, compared to Szczecin, it increases by 10.4% for Lodz and by 32.6% for Zakopane. This is caused by changes in various climate indicators, which determine heat losses and gains in the thermal balance of the building (table 2). However, the magnitude of these fluctuations, even when the locations were accidentally selected by the authors, surprises and convinced about the desirability of returning to the approach specifying the different thermal protection requirements for heated buildings in Poland (primarily regarding the thermal transmittance coefficient values), considering the climatic conditions of the location of the building.

The influence of individual factors was then estimated. According to the developed models, it turned out that for each of the selected locations when the factors U_i changed from the lower to the upper level (table 3), the value of

$Q_{H,nd}$ increases equally: from the factor U_1 by about 11.1%; from factor U_2 by about 7.4%; from factor U_3 by about 10.4%; from factor U_4 by 2.4% and from the U_5 factor by 1.8%. The same percentage effects of factors were obtained in relation to individual models. The effects of factors for the relevant models and climatic conditions, after conversion into physical units, are presented in table 5.

The changes of the required values of the thermal transmittance coefficient of building partitions give diversified effects on the demand for usable energy of a selected building in various climatic conditions. Regarding the climatic conditions of Szczecin, these effects for each factor increase by 6.7% for Lodz and 29.0% for Zakopane (table 5).

Table 5. The influence of changes in the values of factors $X_1(U_1)$, $X_2(U_2)$, $X_3(U_3)$, $X_4(U_4)$, $X_5(U_5)$ from the lower to the upper level, in different climatic conditions

Group of climatic conditions	$\Delta Q_{H,nd}$ effects of changes in the values of selected factors, kWh/year					$\Sigma\Delta Q_{H,nd}$ kWh/year
	$X_1(U_1)$	$X_2(U_2)$	$X_3(U_3)$	$X_4(U_4)$	$X_5(U_5)$	
Effects, %	11.1	7.4	10.4	2.4	1.8	33.1
I	806.00	549.76	762.22	181.56	137.78	2437.32
II	860.76	586.76	811.44	193.12	146.88	2598.96
III	1040.22	709.22	980.32	233.00	177.78	3140.54

Source: author's work.

The total effect from the change from the lower to the upper level of all factors causes a significant increase $Q_{H,nd}$ for the considered building: for I group of climatic conditions from 6350.80 to 8788.12 kWh/year, i.e. an increase of 2437.32 kWh/year (+ 38.4%); for II group from 7055.56 to 9654.52 kWh/year, i.e. an increase of 2598.96 kWh/year (+ 36.8%) and for III group from 8464.52 to 11605.06 kWh/year, i.e. an increase of 3140.54 kWh/year (+ 37.1%). With reference to the I group of climatic conditions, the total effect was 6.6% in the second group and 28.8% in the third group.

The presented results show that currently the approach to approval of nationwide required values of thermal transmittance coefficient, placing all buildings in identical operating conditions is not right and does not allow forecasting the real effects of reducing the demand for utility energy of buildings after toughening requirements throughout the country.

Changes in the required U_i values in force from January 1, 2017, compared to the previous period (from January 1, 2014) (table 1) resulted in a decrease $Q_{H,nd}$ of the analyzed building in the group no I of climatic conditions

from 8558.12 to 7558.15 kWh/year (- 999,97 kWh/year); in the group *no. II* from 9409.21 to 8343.84 kWh/year (- 1065.37 kWh/year); and in the group *no. III* from 11308.31 to 10020.03 kWh/year (- 1288,28 kWh/year).

Further tightening of the U_i to the values to be applied in Poland from 31.12.2020 in relation to the value from the current period will also bring a reduction in $Q_{H,nd}$ of this building: in I group of climatic conditions from 7558.15 to 6350.80 kWh/year (- 1207.35 kWh/year); in the second group from 8343.84 to 7055.56 kWh/year (- 1288.28 kWh/year) and in the third group from 10020.03 to 8464.52 kWh/year (- 1555.51 kWh/year).

The described nature of the factor influence complements the knowledge about energy and economic effects in the heated building from changes in thermal transmittance coefficient U_{max} of external partitions in various climatic conditions.

Annual financial savings caused by a change in the requirements for thermal protection of partitions

Then financial effects were calculated as related to the reduction of heating demand of the analyzed building after the tightening of the required thermal transmittance coefficient values (U_{Cmax}). According to the algorithms in (PL, 2015), the demand for final energy was determined on the basis of formula 18 and the cost of heating according to 19. Fixed charges were omitted due to the fact that their amount was not changed while the building's energy demand was reduced.

$$Q_{k,H} = Q_{H,nd}/\eta_{H,tot},\qquad(18)$$

where:
$Q_{H.nd}$ –   annual heating energy demand, [kWh/year],
$\eta_{H.tot}$ –   seasonal average total efficiency of the heating system [-],

$$K_H = Q_{k,H,nd} \cdot O_z,\qquad(19)$$

where:
K_H –   annual energy cost for heating [EUR],
O_z –   unit price of energy [EUR/kWh].

The adopted average in Poland unit price of 1 kWh of thermal energy for natural gas and the average annual efficiency of the heating system are presented in table 6.

Table 8. The average seasonal efficiency of the heating system and unit price of 1 kWh
of thermal energy for natural gas

Fuel type	The average seasonal efficiency					unit prices O_z
	energy conversion of energy source $\eta_{H.g}$	regulatory control $\eta_{H.e}$	energy distribution $\eta_{H.d}$	energy storage (eg., in tanks) $\eta_{H.s}$	total efficiency $\eta_{H.tot=}\eta_{H.g} \cdot \eta_{H.e} \cdot \eta_{H.d} \cdot \eta_{H.s}$	EUR/kWh
Natural gas	0.94	0.89	0.96	1.00	0.80	0.0687

Source: author's work based on PL, 2013.

Changes in the required U_i values in force from January 1, 2017, compared
to the previous period (from January 1, 2014) (table 1) resulted in a decrease
K_H for the analyzed building of 43 Euros in the first group of climatic condi-
tions; 46 Euros in the second group and 55 Euros in the third group.

Further tightening of the U_i to the values to be applied in Poland from
31.12.2020 in relation to the value from the current period will also bring
a reduction in K_H for this building. This was estimated at 52 Euros in the first
group of climatic conditions, 55 Euros in the second group and 67 Euros in
the third group.

Conclusions

1. Developed deterministic mathematical models allowed to calculate
   energy effects from changes in the $U_{i,max}$ of building partitions that meet
   Polish national regulations from January 1, 2014; January 1, 2017, and
   December 1, 2020. They also allowed estimating the financial benefits
   from a reduction in the usable energy demand of a selected residential
   building under the climatic conditions of three cities – Szczecin, Lodz and
   Zakopane.
2. The change in the required U-values of selected partitions from the level
   meeting the Polish national regulations from January 1, 2014, to the cur-
   rent one resulted in a reduction of the heating demand for a selected
   residential building by 999.97 kWh/year in Szczecin, by 1065.37 kWh/
   year in Lodz and by 1288.28 kWh/year in Zakopane. Financial benefits
   (in a house which uses natural gas as fuel in the heating system) in these
   locations amount to 43 Euros, 46 Euros and 55 Euros, respectively.
3. The change of the required U-values of selected partitions from the cur-
   rent level to the requirements from 31.12.2020 will cause a further

reduction in $Q_{H,nd}$ of the selected residential building by 1207.35 kWh/year in Szczecin, by 1288.32 kWh/year in Lodz and 1555.51 kWh/year in Zakopane. Financial benefits in these locations will amount to 52 Euros, 55 Euros and 67 Euros.

4. The most significant impact on reducing the usable energy demand $Q_{H,nd}$ of a selected residential building has thermal transmittance coefficient of walls (U_1) and windows (U_3), whose total share (after changing the requirements from currently in force to those that will apply from December 1, 2020) for each location is 64.3% of the total decrease from all analyzed factors.

5. It is reasonable to return to the approach determining the requirements for thermal protection of heated buildings in Poland, not the same for the whole country, but varied, taking into account the climatic conditions of the building erection.

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The contribution of the authors

Walery Jezierski – 50%
Beata Sadowska – 50%

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GENERAL
ENVIRONMENTAL
AND SOCIAL PROBLEMS

PROBLEMATYKA
OGÓLNOEKOLOGICZNA I SPOŁECZNA

Anna **STRONCZEK** • Łukasz **WAKSMUNDZKI**

MSGO-ECOTECH SYSTEM AS A TOOL TO SUPPORT ENTERPRISES IN THE IMPLEMENTATION OF EXTENDED PRODUCER RESPONSIBILITY (EPR)

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ABSTRACT: The purpose of this paper is to demonstrate the possibilities of the EcoTech System's solution to support the implementation of the assumptions of the Extended Producer Responsibility. The research methods used to accomplish this goal are literature studies and case study – "MSGO – EcoTech System". EU standards impose a high level of recovery and recycling on the Member States. It is clear that, in order to fulfil the sense of social justice, those who directly contributed to this situation, i.e. consumers and producers, should also participate in this process. However, manufacturers need tools to monitor the efficiency and effectiveness of their operations. The presented "MSGO – EcoTech System" is based on the incentives scheme. The basis is the assumption that companies which declare CSR in their business strategy will join and will participate in the creation of new incentives for citizens. The example confirms that there are modern solutions which can support companies in the implementation of EPR. The obtained results provide guidelines for companies seeking solutions in this area.

KEY WORDS: Extended Producer Responsibility, EPR, waste, EcoTech System

Introduction

The growing world population is accompanied by higher demand for food and other goods. In turn, the increased production of food products leads to an increased amount of packaging waste, such as bottles, boxes and foil (Gómez et al., 2009). The problem of packaging is, first of all, a burden for the environment and a disturbance in sustainable development. Waste perceived as "any substance or object which the holder discards or intends or is required to discard" (Article 3 of Directive 2008/98/EC) accompanies us in everyday life and, as many people imagine, is unavoidable. We create it in our immediate neighbourhood, sometimes even without noticing this fact. In addition, we are rarely aware of the amount of waste we produce. The primary sources of generated municipal waste related to human activity are mainly households and public utility facilities. Collection and accumulation of waste at the place of its generation is the first stage in the system for its removal and neutralization. The most important element of a properly designed municipal waste management system is waste segregation. This segregation may be performed in two ways: through a selective collection system "at source" (in households and other places of human residence) or through secondary segregation.

The European Commission has obliged the Member States to standardize waste management as well as implement the waste handling hierarchy by transposing it to the national legislation (2008/98/EC). This means preference of waste generation prevention, reuse and recycling over any other recovery and neutralization processes. Target levels of packaging waste recycling have also been set.

EU standards impose high recovery and recycling levels on the Member States. The realization of the assumed levels is not only a task of the municipality, or more broadly: the Member States. It is obvious that, in order to satisfy a sense of social justice, also those who directly contributed to the resulting situation should participate in this process, i.e. consumers and manufacturers. The Extended Producer Responsibility (EPR) postulate has been constructed in this spirit. This idea is intensively promoted especially in the context of a circular economy.

Minimum requirements have also been established for all Extended Producer Responsibility systems. Manufacturers of goods covered by these systems must take responsibility for the management of the waste stage for their products: "In addition, obligatory extended producer responsibility systems have also been introduced for all packaging, as reflected in the statement (item 20 of preamble 2018/852/EC). Producers of products should cover the costs necessary to meet the waste management targets and other

targets and objectives, including on waste prevention, defined for the relevant extended producer responsibility scheme" (UE 2018/851/EC): „As the amount and type of packaging used generally depends on choices made by the producer rather than the consumer, extended producer responsibility schemes should be established."

The purpose of this paper is to demonstrate possibilities of the "Motivational Waste Management System" by EcoTech System as a support tool in implementing the assumptions of Extended Producer Responsibility.

Literature review

The common denominator for the Extended Producer Responsibility (EPR) definitions that appear in the literature and normative acts is its perception as an environmental protection strategy/policy under which the manufacturer's responsibility for the product is extended to the whole life cycle of this product[1].

A complex EPR definition was proposed by T. Lindhqvist[2], for whom: „Extended Producer Responsibility is an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product. Producer Responsibility is implemented through administrative, economic and informative instruments. The composition of these instruments determines the precise form of the Extended Producer Responsibility" (Lindhqvist, 2000, pp. 37-38). This author indicates several aspects of responsibility: legal, economic, physical, informational. In doing so, EPR legislation, in principle, shifts the responsibility for, and costs of, negative environmental externalities of products from taxpayers to producers, consistent with the polluter pays principle.

In the EU law, EPR was introduced in the Waste Framework Directive (2008/98/EC), although only the 2018 amendment introduces a definition

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[1]   In addition, the Organization for Economic Cooperation and Development (OECD) published several reports on EPR policies such as: "Extended Producer Responsibility: A Guidance Manual for Governments" (OECD, 2001), "Economic Aspects of Extended Producer Responsibility "(OECD, 2004) and "Analytical Framework for Evaluating the Costs and Benefits of Extended Producer Responsibility Programmes" (OECD, 2005), which are available at: https://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm.

[2]   In 1990, he presented the formal definition of EPR in a report for the Ministry of Environment of Sweden, and it seems that this was the first definition-based approach to this strategy. The inspiration for this definition should be sought in the Swedish 1975 draft Act on Waste Recovery and Management.

of Article 3 p. 21 of the mentioned Directive stating that: '„extended producer responsibility scheme" means a set of measures taken by the Member States to ensure that producers of products bear financial responsibility or financial and organisational responsibility for the management of the waste stage of a product's life cycle' (2018/851/EC. Clarifying that this responsibility includes: (item 14 of the preamble 2018/851/EC) 'separate collection, sorting and treatment operations. That obligation can also include organisational responsibility and a responsibility to contribute to waste prevention and to the reusability and recyclability of products. Producers of products can fulfil the obligations of the extended producer responsibility scheme individually or collectively.' The responsibility imposed can be individual, where a producer takes responsibility for its own products, or collective, where producers in the same product group pay a variable or fixed fee for participation in a Producer Responsibility Organisation (Bio Intelligence Service, 2014).

The Extended Producer Responsibility principle pursues the following waste management objectives (Rosiak-Tatulińska, 2011; Kempa, 1983):
1) maximum reduction in the quantities of municipal waste during any business operations and in people's households,
2) immediate incorporation of production residues again into production,
3) recovery of raw materials from collected waste,
4) application of waste neutralization processes,
5) waste storage in an ordered manner with a guaranteed minimum burden for the environment.

The main purpose of this principle is to apply legal instruments encouraging producers to take actions that will prevent waste generation, reduce the material and energy consumption level at every stage of the product life cycle and offering incentives for introducing changes in the product design phase and the manufacturing phase. In a broad perspective, the extended producer responsibility principle is combined with the principle of material producer responsibility for the product (Karpus, 2014). The final aim of EPR is to address issues related to resource consumption and growing waste generation, a key rationale being that producers are best suited to make the required changes to achieve a reduction in the environmental, social and economic impacts of their products.

The EU legislator determined the instruments that can be used in the process of implementing EPR (table 1). Still, prescriptive instruments may only be used in the life cycle phase when the product has already become waste. In the product life cycle phases that precede generation of waste, the instruments can assume incentives to reduce adverse impacts on the environment (Piontek, 2018). And it is the incentives system the model proposed by EcoTech System is based on.

Table 1.   Typologies of EPR policy instruments

Tpologies of instruments	Policy Instruments
Administrative	landfill and incineration bans material restrictions eco-design requirements related to reuse/recycling, minimum recycled material content standards source separation/collection requirements waste prevention requirements waste prevention targets collection targets landfill/incineration diversion targets reuse targets recycling targets recovery targets
Administrative/economic	producer take-back requirements
Economic/Market Based	deposit-refund systems producer responsibility taxes on virgin materials taxes on hazardous substances landfill and incineration taxes/charges waste disposal taxes/fees/charges recycling fees/charges product taxes/charges tradable recycling credits
Informative	information provision requirements, eco-labels

Source: Saki, 2011.

Proposed support tool for EPR
Conceptual assumptions of MSGO-EcoTech System

The amount of municipal waste generated in Poland in 2017 reaches 312 kg per citizen, which together gives almost 12 million tons of waste (GUS, Environmental protection 2018). Packaging waste accounts for a substantial part of this quantity. According to a report prepared to the order of Zero Waste Europe, only 45% (by weight) of the packaging waste manufactured in European cities is managed within ROP systems, which is only 18% of the total mass of generated municipal waste (Zero Waste Europe, 2017, p. 9).

The EPR idea has also been extended to responsibility for packaging introduced into production. It is the implementation of the EPR assumptions in the area of packaging that requires relevant support.

EcoTech System starts a new service on the Polish market for effective recycling of packaging waste, called "Motivational Waste Management System by EcoTech System" – *Motywacyjny System Gospodarki Odpadami EcoTech System* (MSGO-EcoTech System). The proposed solution is an innovation of process nature, the aim of which is to ensure an effective and pro-social way of waste segregation causing a change in behaviour and habits of residents and common education with the use of motivational factors. The innovation for effective recycling of packaging waste at "source" supplements the current segregation methods. The novelty consists of rewarding segregation and activating people for its proper implementation. MSGO EcoTech System is also an innovation in the product aspect, utilizing two elements: IT system

(EcoTech System Platform) and reverse vending machine, the so-called recyclomats. Recyclomat and MSGO Eco-Tech System are the trade mark of EcoTech System.

The central element of the system is EcoTech System Platform – the IT system for managing, counting, monitoring, and managing the whole flow of information and recyclable materials in real-time. Recyclomats are synchronized with the central platform and the mobile application, allowing the users to use the network of machines installed anywhere. Recyclomats installed in public places should ensure an automatic system for direct waste segregation, offering a motivational discount program in return – e.g. discount coupons for use in retail and service outlets of business partners associated on the EcoTech System Platform (figure 1).
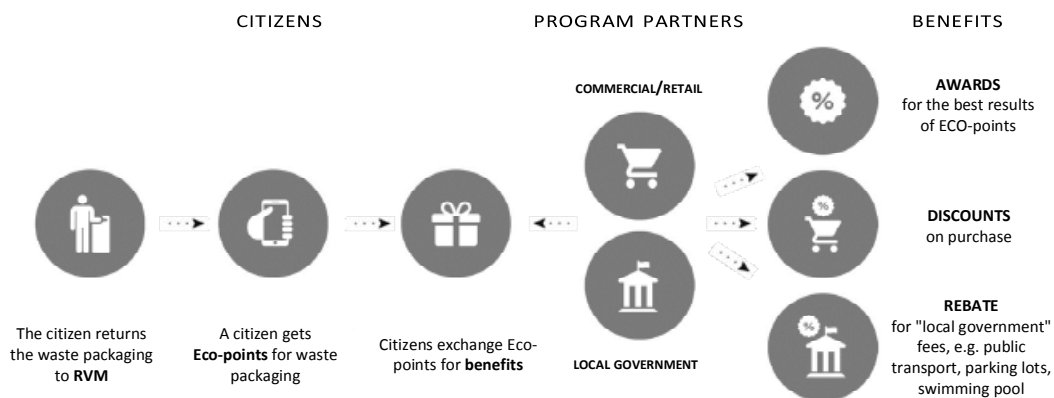
Figure 1. MSGO-EcoTech System functioning principle

Source: EcoTech System's internal materials.

Kunz, Mayers, and Wassenhove (2018, p. 53) included the following in the EPR stakeholder groups:
- Producers.
- PROs – Producer Responsibility Organizations (organize the collection, treatment, and recycling activities under EPR on behalf of producers, sts by charging a fee to the producers they represent). EPR on behalf of producers. 60 PROs cover their operating costs by charging a fee to the producers they represent.
- Waste operators – Waste operators, carry out waste collection, transport, treatment, and recycling of waste on behalf of PROs. This stakeholder group is commonly referred to as "recyclers".

- National authorities – are the regulatory bodies responsible for transposing EU directives into national legislation and ensuring targets imposed by the directives are achieved.
- Municipalities – are local authorities providing and organizing waste collection activities within their area.
- Trade associations – all professional associations that represent a given sector.
- Clearing houses – Clearing houses are organizations created by national authorities to register producers and collect data on their sales volumes. They also compile information on waste collection from PROs and determine the obligations for each producer.

It should be highlighted that the above indicated groups of stakeholders were separated within institutional solutions being in force in the United States, where the quoted authors conducted their research. "Clearing houses" have not been formed in the Polish reality.

The foundation for "MSGO-EcoTech System" is a synergy of all the model participants creating the so-called 4 x WIN strategy. The project beneficiaries are all the parties involved. And so:

1) citizens – motivation for segregation,
2) local government – achieving required recovery and recycling levels,
3) recycling industry – access to clean recyclable materials,
4) business partners – promotion by environmental protection, implementation of CSR assumptions.

As it can be easily noticed, the parties are the same as those indicated in the earlier deliberations as the EPR stakeholders.

Recyclomats installed in public places should ensure the automatic system for daily waste segregation, offering in return a motivational discount program – e.g. discount coupons for use in retail and service outlets of business partners associated on the EcoTech System Platform.

The reverse vending machines are connected with ECO-Wallet mobile application which should be launched before starting packaging waste segregation. In the next step, bottles or cans should be thrown into the machine slot, the individual QR code should be read from the phone, and the process should be continued until all waste is disposed of. The process ends with the calculation of ECO-points, which can be exchanged for various types of discounts (for example in public transport or in cinemas).

The collected points may be used in competition for prizes and exchanged for discounts in retail and service outlets of the business partners associated on the EcoTech System Platform Thanks to this cooperation, business partners obtain not only new eco-customers, but have an opportunity to run their own advertising campaigns, promote a selected product group or determine

the discount level depending on the amount spent. The platform provides access to data and reports in real-time in the scope of the realized recovery and recycling levels in the given area, with a breakdown into the amount of raw material, type, weight and exact collection point. Thanks to this cooperation, business partners have an opportunity to run their own advertising campaigns, promote a selected product group or determine the discount level depending on the amount spent. The platform provides access to data and reports in real-time in the scope of the realized recovery and recycling levels in the given area, with a breakdown into the amount of raw material, type, weight and exact collection point (Waksmundzki, Stronczek, 2018). The proposed solution, on the one hand, is compatible with the assumptions of the circular economy (figure 2) but, on the other hand, constitutes a tool supporting EPR (figure 3).
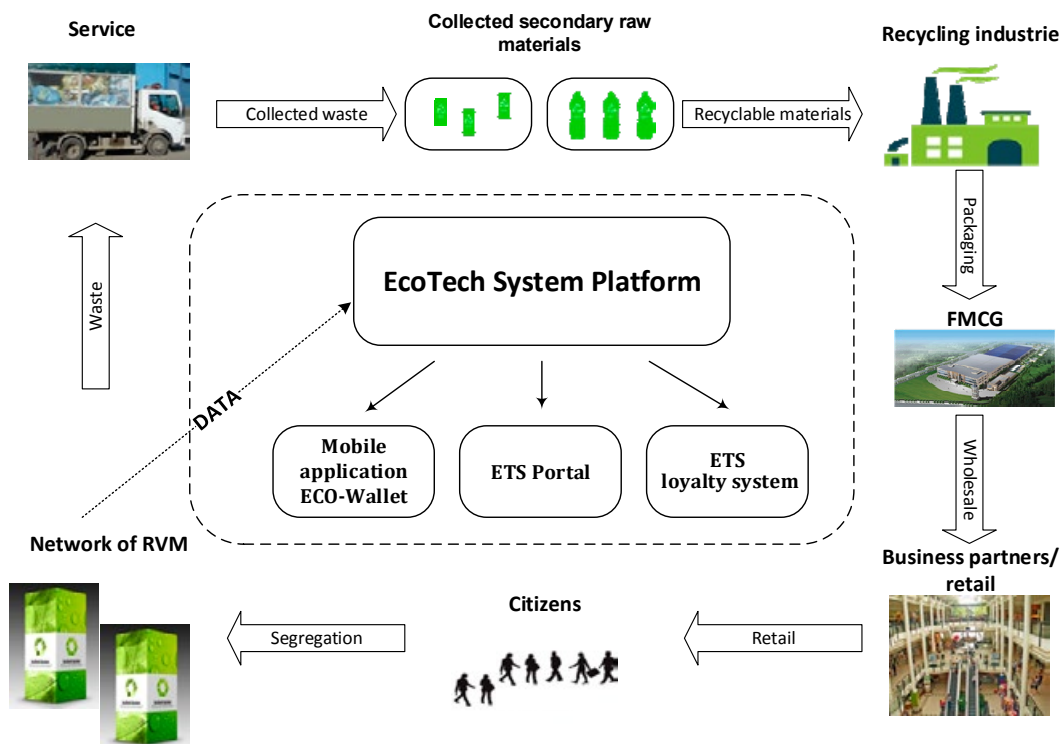
Figure 2. Circulation of waste/recycled material with the use of the EcoTech System Platform as a Circular Economy tool

Source: EcoTech System's internal materials.
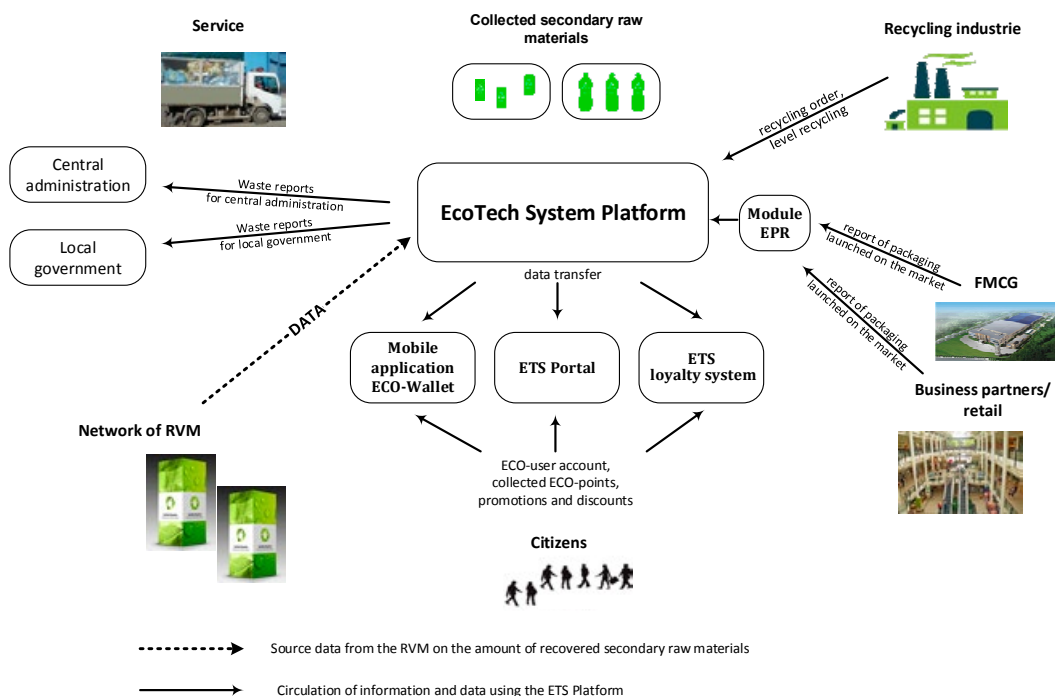
Figure 3. Circulation of information/data on the EcoTech System Platform as a tool supporting EPR

Source: EcoTech System's internal materials.

MSGO-EcoTech System – Coca-Cola case study

An example of using MSGO to implement tasks from the EPR area is Coca-Cola's action, taken as part of the global campaign: #neversettle. Coca-Cola Company's ambitious goal until 2030 is to collect and transfer for recycling as much packaging as it hands over to the consumers, and that all marketed packages are composed of recycled material in at least 50 percent by 2030. It is not difficult to notice that the company's strategy is shaped by EPR and Circular Economy. EPR aims to achieve environmental improvement throughout the product life cycle and has two primary environmental goals. The first is to encourage manufacturers to design resource-efficient and low-harmful products. The second is to ensure the effective collection of used products and environmentally friendly processing of collected products and better reuse and recycling. The foundation of the EPR approach is, therefore, to establish a feedback loop so that improvements in product design help optimize their environmental performance and minimize decommissioning

management costs. In this way, EPR is linked to both product design and mandatory policy goals, ensuring a link between product design and post-use processing, and between policy and implementation (Zero Waste Europe, 2017).

Under the project, 10 recyclomats will finally be installed within the capital city of Warsaw. In the first stage, 2 pieces of recyclomats were launched, and a system of incentives (reductions and discounts) was provided by 4 project partners: Costa Coffee, Multikino, Teatr Dramatyczny (Dramatic Theater) and Capitol Theater. The interest of residents in the modern way of segregation using the ECO-Wallet application and in collecting ECO-points exceeded optimistic forecasts. During the first two months, the ECO-Wallet application was downloaded by 9,630 users, 14,026 transactions were carried out, 147,964 pieces of packaging waste for recycling were collected (see table 2).

Table 2.   Project data

registered users	7 643
registered transactions	14 026
installed applications including: • IOS • Android	9630 • 3 720 • 5 910
of collected waste including: • PET • ALU • glass	147 964 (100%) • 89 196 (60.28%) • 41 338 (27.94%) • 17 430 (11.78%)

Source: EcoTech System's internal materials.

The project lasted 8 weeks. In that time, a registered user used a recyclomat on average 1.8 times, providing 19.35 pieces of waste in the transactions. PET packages were disposed of most frequently (there were 11.67 of them per transaction). The largest registered transaction (2019/08/25; 09:00:25) for a total of 328 returned packages was carried out by a person who visited the recyclomat 4 times in total.

At the moment, works are underway in the area of the module recognizing the packaging type, in order to identify the producer that it was marketed by, in the event that there is no label.

It turned out that the incentives system proposed by the partners was sufficient for the residents to segregate waste using recyclomats on a regular basis. The project confirmed that the residents want to be environmentally friendly, want to segregate waste and want to create EcoSmart City.

In addition, in the first week after the project launch, the ECO-Wallet application (in polish called: ECO-Portfel) was one of the three most frequently downloaded (popular) apps on play.google.com and appstore.com.

Conclusions

The realization of the circular economy model requires the extended producer liability systems to be shaped and developed on the basis of a properly defined social interest. As rightly noticed by W. Piontek (2018), this process cannot be limited solely to the transposition of EU directives into the national law, or be conducted under the influence of lobbying institutions representing industry interests. Therefore, the introduction of incentives systems within EPR should be considered. A tool supporting such a policy can be the proposed MSGO-EcoTech System model. The more so that it is a powerful tool of multi-dimensional information management (Big Data, BI, IoT, AI, predictive analysis)[3].

For the effectiveness of the project, it is important to prepare a wide range of incentives and rewards. The innovation assumes that companies which declare CSR in their business strategy can join by participating in an incentive scheme for citizens. At the same time, it should be believed that the legislator will notice that participation in such a voluntary program is a realistic way of fulfilling the obligations from extended producer responsibility.

The research by Elinor Ostrom, a Noble Prize winner in economics, on effective management of common goods proved that surprisingly many people, institutions and organizations voluntarily take common action for nature and environmental protection (Ostrom, 2010). She also denied the traditional views that desirable goals in the field of environmental protection can be achieved only with orders and prohibitions (Poteete et al., 2010).

Therefore, we should remember that manufacturers do not necessarily need legal regulations to demonstrate their willingness to take action for environmental protection. They often pursue such initiatives without any compulsion from a normative act, within the implemented CSR strategy. However, manufacturers need tools for monitoring the effectiveness and efficiency of their actions.

Presented solution confirms there is a modern way for companies to support EPR obligation. Received results can be used as best practises for companies which are looking for any solution in this area.

The strengthening and expansion of producer-led program development and autonomy in EPR policy are arguably necessary to truly fulfil the intent of integration of EPR into the business model of firms.

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[3]   This issue goes beyond the scope of this study.

It is necessary to consider conducting field research in Polish companies using the presented system. The research will determine the impact of the innovation on the realization of assumed recovery levels by company.

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The contribution of the authors

Anna Stronczek – 60%
Łukasz Waksmundzki – 40%

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INSURANCE AWARENESS IN THE FIELD OF WEATHER RISKS

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ABSTRACT: The aim of the article is to assess the changes in the insurance awareness of entities in the field of weather risks. Studies that were carried out recently indicate that from the point of view of the client, the attractive price combined with the comprehensive service plays an important role. The interviewees emphasized that the inclusion of new threats and matching the offer with the needs of the buyer may significantly affect the demand for insurance services. Consumer interest in products in the area of weather risks depends on the scope of protection, the amount of insurance premium and innovative solutions in the process of distribution (including the mutual insurance system).

KEY WORDS: insurance awareness, insurance market, insurance services, weather risk

Introduction

Different types of risks are inscribed in our everyday functioning and business activities. Commonly the term risk is used in the case of unfortunate accidents, unforeseen events, the possibility of incurring losses or the possibility of obtaining a different result than expected (Sokołowska, 2008, p. 1; Michalski, 2004, p. 46). The insurance provides protection against the negative effects of random events and compensation of their impact under the conditions specified by the insurer.

The consequences of being not insured can be very severe. It may disturb the functioning of individual persons and business entities. In many cases, it causes great difficulties to states and their governments. Payment of benefits and compensation to persons who, for various reasons, have not decided to protect their life, health or property constitute a significant burden on the state budget.

Accidents can't be excluded. However, proper caution, appropriate preventive measures may minimize the potential risks that accompany each venture. Insurance companies aim to limit the possibility of random events. As financial intermediaries, they transmit risk, spreading the financial losses into many entities. Compensation and benefits paid by the insurance companies increase consumption as they are used for restitution and purchase of durable goods. Insurances play the role of quasi-automatic stabilizers and can be considered as a factor that strongly stimulates economic and social change.

The shaping of insurance awareness, undertaking actions that may lead to its growth, can significantly affect the increase of the demand for insurance products providing protection against the adverse effects of violent weather events. According to various estimates, around 70% of the world economic activity is exposed to the variability of weather conditions (Burnecki, Kukla, 2001, p. 26). The weather directly or indirectly affects the size of the business, the revenues and costs of three out of four companies (Michalak, 2011, p. 41), representing various industries (e.g. energy, construction, agriculture, forestry or tourism). That's why the weather risk management and implementation of some new solutions are very important from the perspective of individual entities as well as the entire economy.

The growing number of natural disasters makes handling catastrophic insurance difficult for insurers and reinsurers, which usually bear financial responsibility. The solution promoted in highly developed countries is a comprehensive system of cooperation between the state, citizens and insurers (Michalak, 2015, p. 42).

An overview of the literature

The author was interested in the aspects of transformation taking place on the insurance market in Poland and undertook an attempt to identify the factors determining the insurance awareness of entities in the field of weather risks and the innovation processes in this area. Insurance companies introduce new products, modify their offer or apply the alternative distribution channels. In this way, they try to attract new buyers and increase the loyalty of existing customers.

The analysis of the insurance awareness was based on publications of such authors as: Wieteska (2010a, p. 233), Grzebieniak (2008, p. 276), Szumlicz (2006, p. 21), Pazio and Formanowska (2002). The mentioned researchers dealt with the term – insurance awareness or awareness in general. They explained this issue by giving its definition and outlining the factors influencing its size. The main attributes of this concept presented by the author of this article were shown in a more detailed way in the books listed above.

Research on the weather risks was referred to articles and books prepared by Burchard-Dziubińska (2016, p. 46-56), Czekaj (2016, p. 217-228), Michalak (2011, p. 41-47; 2015, p. 41-55), Preś (2007), Pawłowski (2014).

The main aspect of the conducted analysis is connected with the impression that the range of instruments is wide, but still, some entities can't afford them or think that they can't use this kind of protection due to the high amount of insurance premium. Different institutions from the insurance/financial market may play a significant role in the process of shaping the insurance awareness and broadening the knowledge about useful protective instruments against the weather risk.

Research methods

The conclusions presented in the publication were based on studies of the literature and on the author's own research. Factors determining the insurance awareness of participants of the insurance services market in the area of the weather risks were identified along with the analysis of the relevant legal provisions, statistical data. Unstructured interviews with experts were carried out in 2018 with representatives of the Directorate of the leading (i.e. with a high market share) insurance companies on the Polish market (AXA ŻYCIE TU S.A., AXA UBEZPIECZENIA TUiR S.A., TUnŻ CARDIF POLSKA S.A., CREDIT AGRICOLE TU S.A., NATIONALE-NEDERLANDEN TUnŻ S.A., NATIONALE-NEDERLANDEN TU S.A., PZU ŻYCIE S.A., PZU S.A., TUW PZUW, UNIQA TU na Życie S.A., UNIQA TU S.A., TUnŻ WARTA S.A., TUiR WARTA S.A.).

According to the companies representing the life insurance sector, the protection of life connected with the weather risk is included in the 1st group/class (out of 5). In the case of the non-life sector, the analyzed insurance is offered within 8th, 9th and 16th class (out of 18).

Table 1. Information about interviewed companies

No.	Name	Date of issuing the authorization	Date of selling the first insurance policy	Share in life/ non-life branch premiums (2018)	Capital
1.	AXA ŻYCIE TU S.A.,	23.06.1993	12.07.1994	3,24	Foreign (100%)
2.	AXA UBEZPIECZENIA TUiR S.A.	19.12.2006	13.02.2007	5,1	Foreign (100%)
3.	TUnŻ CARDIF POLSKA S.A.	22.01.1998	01.05.1998	0,95	Foreign (100%)
4.	CREDIT AGRICOLE TU S.A.	07.10.2014	08.12.2014	0,05	Foreign (100%)
5.	NATIONALE-NEDERLANDEN TUnŻ S.A.	02.08.1994	01.01.1995	6,99	Foreign (100%)
6.	NATIONALE − NEDERLANDEN TU S.A.	04.10.2016	04.09.2017	0,02	Domestic (100%)
7.	PZU ŻYCIE S.A.	20.12.1991	20.12.1991	38,66	Domestic (100%)
8.	PZU S.A.	03.01.1947	03.01.1947	32,14	Domestic (100%)
9.	TUW PZUW	03.11.2015	29.02.2016	0,12	Domestic (100%)
10.	UNIQA TU na Życie S.A.	23.03.1994	29.06.1994	0,5	Foreign (99,78%)
11.	UNIQA TU S.A.	12.02.1990	01.09.1990	1,96	Foreign (98,59%)
12.	TUnŻ WARTA S.A.	21.01.1997	10.07.1997	3,73	Domestic (100%)
13.	TUiR WARTA S.A.	01.09.1920	01.09.1920	16,35	Foreign (100%)

Source: author's work based on www.knf.gov.pl [10-02-2020].

The meetings were arranged with directors of a given company or managers of different departments (i.e. Bancassurance Area, Sale, New Products and Innovations, Business Development), mostly located in Warsaw. Only a few of them took place in Łódź. The whole discussion usually lasted about one hour and a half. It was recorded. The interviewed persons fulfilled the questionnaire prepared by the author.

Unstructured interviews with experts were used to obtain professional comments on the determinants of the changes in insurance awareness in the field of weather risks.

The analysis was aimed at finding answers to the following research questions:
• what is the meaning and significance of the insurance awareness and specificity of the weather risks?

- which groups of clients may be interested in this kind of protective instruments?
- whether the available solutions provide the effective protection of entities in the analyzed area?

The problems listed above are discussed in a more detailed way in the following chapters of this article.

Results of the research

Insurance awareness is treated as: "a specific, but variable in time, intellectual state of individuals and society, which results from the level of knowledge, understanding and rational valuation of facts and events taking place on the insurance market" (Pazio, Formanowska, 2002). According to W. Sułkowska (2000, p. 72), insurance awareness is a social value that is one of the basic determinants of the intellectual level of individuals and social groups.

This term can also be explained as a psychological state in which the consumer is aware of various insurance events occurring on the market and then is able to react appropriately (Grzebieniak, 2008, p. 276).

While examining attributes of consciousness T. Szumlicz (2006, p. 21) defines it as: "knowledge and skills enabling the rational use of insurance protection and in consequence demonstration of the precautionary approach." In his opinion, insurance awareness is determined by the knowledge of risk, general insurance conditions, principles of insurance protection, the sales process, after-sales service or institutions within the insurance market. Shaping customer awareness requires thus, proper education. Insurance companies, agents and brokers are increasingly engaged in those types of actions. An important role is also played by the activities undertaken in this field by the Polish Insurance Association. It maintains educational websites, develops cooperation with scientific and student organizations, holds patronage over post-graduate studies and conferences, and supports insurance initiatives of scientific associations.

The ongoing process of consumer self-education is also becoming increasingly important (Grzebieniak, 2008, p. 278; "Czy Polacy są odpowiedzialni?").

Concerning the second aspect of the conducted analysis, the term "weather risk" requires an explanation. It is understood as the negative impact of fluctuating weather conditions on business activities. These factors have always been around us and had an influence on human life. Today, however, they have gained meaning due to their accelerated and strengthened character (Blachowski, 2011, p. 639-640).

Weather risk, due to its impact on the environment, is divided into two groups (Michalak, 2011, p. 42):

- catastrophic risk (a result of earthquake, hurricane, tornado, flood, heavy rain, hail, thunderstorms and snowstorms or extremely high temperatures; it affects enterprises, households),
- non-catastrophic risk (connected with the deviation of weather conditions from their average, normal state; above-average or insufficient rainfall or snow, increased heat or cold, more windy or windless days).

The frequency and intensity of extreme weather events in the world is often associated with climate change. Research centres try to create forecasts for economic development, energy consumption and emission of pollution to assess the impact of climate change on socio-economic development. In this way, they can determine the degree of vulnerability of various regions to changing climatic conditions and thus also the possibilities of dealing with extreme weather events. In economically underdeveloped regions, the adaptability of human systems is usually assessed as low due to a lack of financial and technical resources, poverty, the dependence of agriculture on rainfall, droughts or floods. As a consequence, agricultural yields (mainly cereals) may decrease, what threatens food security, especially in the region of poor countries in Africa, Asia and Latin America. Highly developed areas show significantly lower vulnerability to climate change and higher adaptability to new conditions, which is associated with their financial and technical capabilities (Burchard-Dziubińska, 2016, p. 47). They can implement advanced construction techniques (like in Japan, where the buildings become more resistant to earth surface vibrations) and consider changes of their localization or having branches in different regions. They may also introduce forecast systems and better risk management methods (Pawłowski, 2014, p. 255-256).

In July 1997, southern Poland, the Czech Republic and part of Austria were hit by a flood, (called the flood of the millennium). It took the lives of 114 people. The losses caused by heavy rainfall were estimated at 4.5 billion euro. Over 9,000 enterprises lost their assets ("Derywaty pogodowe…"). The above example shows how great influence the weather can have on business. Each of the companies had plans, commitments and contractors. Flood or drought are able to mess up the company's budget and lead to its bankruptcy. But sometimes even an unexpectedly low or high temperature or longer than planned rainfall can trigger severe consequences.

For residents, warm winters mean the reduced heating time. They don't have to heat their flats as intensively as during heavy winter. But in the case of an energy plant, the assumed plan won't be implemented. The heat and power industry is not the only one for which a plus on the thermometer

means a minus in the profits. The entire tourism sector also closely monitors weather forecasts. If guesthouses and agrotourism farms expect higher interest from the side of the guests, they often invest in their facilities and tourist offer before the season starts. Unfortunately, however, it happens that the winter is too warm and there is not enough snow. This generates a decrease in interest in a given location and a significant reduction in expected revenues. In such cases, not only adequate earnings are taken into account, but often the reimbursement of incurred costs. Temperature affects the volume of sales of cooling drinks. In the case of business operations connected with the snow removal from roofs, the absence of snowfall means that they become pointless.

The owners of the restaurants earn less on so-called "beer gardens" during rainy days. For farmers, prolonged drought means poor harvests. Owners of golf courses during wind or rainfall can't count on much interest either. Strong wind/heavy rains can even mean the cancellation of the event and as a consequence, huge financial losses.

However, material losses caused by weather conditions can't be ignored. The company's assets may be destroyed (e.g. strong winds may cause damage to the roofing, lightning may strike fire in the building), but also the weather can affect the quality of the enterprise's products (e.g. too high humidity is not conducive to the storage of some products).

In the case of material losses, traditional insurance is used. However, in the case of regions where the probability of occurrence of some random events is very high, it leads to the much higher insurance premium. Not every person or a company can afford this protection even if they are aware of the weather risk and consequences of extreme weather phenomena.

Index insurance is another kind of protective instrument. It can be useful when the weather affects the entity's revenues. Weather derivatives are based on weather conditions (levels of rainfall or snowfall, higher or lower temperature or wind speed). Those instruments are bilateral futures contracts. They are usually used in non-catastrophic weather risk management. However, they are increasingly implemented for investment purposes as an attractive element of portfolio diversification. The company, which uses weather protection, receives payment when the conditions specified in the contract occur. Depending on whether the company is sensitive to temperature, rainfall, snowfall or wind, an appropriate index is constructed. It can take any form starting from the simplest: average temperature, average rainfall or average wind speed, ending with more advanced: degree day, cumulated wind speed index. It is obvious that indexes simpler in construction are easier to understand and to accept by the customer, but they are characterized by lower efficiency than those more advanced instruments. Based on the

meteorological observations of temperature or rainfall in a given period, a weather index is built. It will reflect changes in the company's revenues or expenses. The next step is to assess how much the company can gain/lose if the index changes by one point. Finally, the collateral period and the type of financial instrument are determined.

Let's assume that the owner of a wind farm is afraid of insufficient electricity production resulting from variable wind speed, and hence the unpredictability of using the installed power capacity. This situation can significantly affect the financial results and cause difficulties related to the repayment of loans to institutions financing the investment. Therefore, the farm owner, by purchasing collateral against non-catastrophic weather risk – in the form of a derivative or insurance – will ensure the expected level of revenues. The wind speeds lower than the specified in the contract is a condition for obtaining payment for the purchased collateral.

As it was mentioned earlier, the amount of insurance premium is an important factor influencing the demand for the insurance products. Interlocutors of the author underline that many entities can't afford this kind of protection. Clients emphasize that the probability of occurrence of some random events is still very low. But they should bear in mind that potential losses are many times higher than the level of insurance premium. Besides, the financial support given by the state in the case of catastrophic events won't cover the size of damages caused by storms, heavy rains or hail.

Mutual insurance system can be a solution to the problem of limited access to insurance products against weather risks. According to the ICMIF (International Cooperative and Mutual Insurance Federation) and AMICE (Association of Mutual Insurers and Insurance Cooperatives in Europe) data, the share of mutual societies in the global insurance market in 2014 was 27% and in the European market – 31%. In Austria, it accounted for 61% and in the Netherlands – 51%. In countries as Sweden, France or Denmark, the share of mutual insurance undertakings was over 45% (Burz, Biel, 2017, p. 20 and 28). Currently, in Finland, they constitute approx. 80% of the market, in the USA approx. 50%, while in Poland – 6% (Olszewski, 2018). Mutual insurance enables the reduction of the policy costs, but also the protection of a much larger scope (in the case of commercial insurance the price will be too high, and a wide range of protection won't be available). Moreover, the damage settlement is done by a professional insurance company. Besides, mutual insurance reduces the risk of fraud. It is difficult to imagine a situation that someone will destroy his/her property to obtain compensation. Another advantage of this insurance model is connected with solidarity and long-term protection. Normally – the Public Procurement Act requires that the insurance contract can be concluded by the local government for a maximum of

three years. In the case of mutual insurance companies (in Polish towarzystwa ubezpieczeń wzajemnych – TUW), there is no such restriction. The longer this cooperation is, the better is the insurance price. The basis of such cooperation is the trust that is built up over the years.

Polski Zakład Ubezpieczeń Wzajemnych was the first company that prepared an offer for hospitals or local governments (an agreement was signed with the city of Lodz). TUW PZU is a start-up, but at the same time, it is part of the PZU SA group, which helps build credibility on the market. According to the Global 500 report prepared by the ICMIF, TUW PZUW is the second fastest-growing mutual insurance company in the world. In 2017 it gathered a gross written premium of 101,6 million USD with its dynamics at the level of 178%. The leader of that ranking was the German Pensions-Sicherungs-Verein with the result of 840,6%. TUW PZUW was included in that report for the first time („TUW PZUW w światowej…").

Tadeusz Kowalski, the mayor of Tuchola, which was hit by a gigantic natural disaster in 2017, admits that mutual insurance is a suitable solution for local governments. The unexpected storm destroyed 16,000 hectares of forest, municipal infrastructure, houses, outbuildings and power lines. Energa, which was covered by mutual insurance at the TUW PZUW, quickly obtained funds to repair the most urgent damages. The TUW uses the network of claims adjusters of the largest Polish insurer on a daily basis. Municipalities must protect themselves against risks, including those which they can't foresee. Wojciech Grela, deputy mayor of Raciechowice (Myślenice county, małopolskie voivodeship) admits that thanks to this solution everyone in the commune can feel more confident. "We would like to insure almost everything, but when the premium is as low as possible". Cyclical floods are the biggest problem, and TUW meets the insurance and protection conditions (Olszewski, 2018). According to ICMIF experts, the development of the mutual and cooperative insurance is possible due to the combination of management openness for the needs of the modern market with a rich tradition of reciprocity dating back to the beginning of the XX century („TUW PZUW w światowej…").

Conclusions

The knowledge that we have about the insurance market, about conducting business on it, about the institutions and products has a strong impact on our awareness and the need to protect our family, ourselves and our assets. Better knowledge results in higher customer requirements while using financial services. Changes evident in consumers' awareness are not only the manifestation of current development trends in the insurance market. The emer-

gence of new threats generates increased demand for services that can protect against the negative effects of various random events. Entities can decide either for traditional insurance products or weather derivatives. Another way of protection against the effects of weather risk is to change business locations or to have branches in various geographical regions. The importance of the development of construction engineering is also worth mentioning.

Customers' previous experiences or opinions of other buyers are also significant. A satisfied client usually provides an additional customer for the insurance company, but the dissatisfied one gives his bad opinion to usually three times higher number of his/her friends than in the case of positive experiences. Spectacular events, extreme weather events, and random events adversely affecting the situation of our relatives, friends, business partners usually lead to the growth of interest in specific insurance products. Insurance awareness increases especially in the context of various negative events facing people and entities from our environment.

Due to the complexity of the Earth's ecosystem and the multitude of impacts affecting the climate, it is difficult to accurately predict the effects of its changes, as well as the impact on the occurrence of extreme weather events. This creates new challenges for the insurance sector, which must reassess risk and value its own products. The availability of weather risks insurance in some areas becomes increasingly difficult, and the cost may be an economic barrier to its use. An attractive solution may be the support from public funds, especially in the sphere of physical risk control, which may reduce the price of policies. The state should initiate the creation of insurance pools or provide a guarantee of the payment of damages. Actions planned and undertaken by the state should result from a coherent policy, which would create a favourable climate for the further development of the insurance market.

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TOURIST TRAFFIC IN NATIONAL PARKS IN POLAND

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ABSTRACT: The article aims to assess the size of tourism in national parks in Poland in 2004-2017, with particular emphasis on the Tatra National Park (TPN), a park with high tourist attendance. The study investigates the dynamics of tourism in national parks as well as the size, character and spatial distribution of tourism in the TPN. It also shows the conditions of tourist traffic management in national parks and its importance both for nature and for the budget of these organizational units. The analysis was based on data from the studies of the Central Statistical Office concerning environmental protection and data concerning the access to the Tatra National Park. The dominant features of tourism include its dynamic growth in the period under study and record attendance in the Tatra National Park, especially around August 15 on the trail leading to the Morskie Oko lake and the Valley of Five Polish Lakes (Dolina Pięciu Stawów Polskich).

KEY WORDS: national park, tourist traffic, Tatra National Park

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Introduction

The Act on Nature Conservation establishes forms of nature protection binding in Poland, which include national parks, nature reserves, landscape parks, "Natura 2000" areas, protected landscape areas, nature monuments, documentation sites, ecological grounds and natural and landscape complexes (Act of 16 April 2004, Article 6). The areas covered by the indicated forms of protection cover 32.5% of the country's area. So far, 23 national parks have been created in Poland. They occupy a total area of 315.1 thousand hectares, which is 3.1% of the area covered by nature conservation and 1% of the country. The largest one is the Biebrza River National Park (59,233 ha), while the smallest one is the Ojcowski National Park which covers 2,145.7 ha (GUS, 2018, pp. 104, 107, 108).

A national park is defined in the Act on Nature Conservation (Article 8(1) and (2)) as an area distinguished by a specific natural, scientific, social, cultural and educational values, with an area of not less than 1000 ha, on which all nature and landscape values are protected. It is created to conserve biodiversity, resources, formations and components of inanimate nature and landscape values. It aims at maintaining the proper condition of natural resources and restoring distorted natural habitats, plants, animals, or fungi. National parks are the most valuable areas in terms of nature resources; therefore, they are covered by the highest level of protection. Their natural and cultural riches have gained recognition worldwide. The Biebrza River, part of the Karkonosze, Narew River, Poleski, Słowiński, Wigry and Warta River parks are covered by the Convention on Wetlands, also known as the Ramsar Convention, of international importance, especially as the living environment of aquatic birds. The natural value of these areas was also confirmed by UNESCO, which entered the Babia Góra, Białowieża, Bieszczady, Bory Tucholskie, Kampinoski, Karkonosze, Poleski, Roztocze, Słowiński, and the Tatra national parks as Biosphere Reserves, and recognized the Białowieża National Park as World Heritage site (GUS, p. 107; Grabowski, Kotyła, 2019).

Initially, the most important tasks of national parks were nature conservation and conducting natural scientific studies. Today, however, parks have acquired new tasks that cause certain effects of economic and social character. Currently, the main task of national parks is to (the Act of April 16, 2004, Article 8b item 1):
- conducting protective measures in ecosystems of the National Park, aiming to achieve the purpose for which national parks were established, and thus preserve their biodiversity, resources, formations and elements of inanimate nature and landscape values, restore the proper state of

resources and elements of nature, reconstruct distorted natural habitats of plants, animals or fungi,

• making the area of the national park available to the public on terms specified in the plan of protection or conservation tasks and in the ordinances of the director of the national park,

• conducting activities related to education regarding nature.

The aim of the article is to assess the size of tourism in national parks in Poland in 2004-2017, with particular emphasis on the – Tatra National Park (TPN), a park with high tourist attendance.

Determinants of making national parks available for tourism

National Parks are areas located in the most attractive places in Poland in terms of natural resources and landscapes. Therefore, the task of making them available for tourism is very demanding. In order to meet this challenge with the least possible damage to nature, tourist trails are maintained as is appropriate infrastructure (hostels, shelters, camping sites and grounds), and sanitary facilities are built.

According to the Act on nature conservation, a park area should be made available in such a way that tourism does not adversely affect the protection of nature. There is a problem of tourist overload, which is caused by the same factor as the establishment of each of the parks. The fact that nature is protected for the tourist and against the tourist at the same time is being discussed more and more. Management of tourist traffic in national parks, especially in the most crowded ones, is a very difficult task. Despite channelling tourist traffic by creating a network of hiking trails, too much tourism hurts nature. Tourists themselves are a threat to the protected nature if they break the rules and lack good manners. Loud behaviour, feeding animals, littering, picking plants, going off the marked trails, which, among other things, triggers erosion, defecation and urinating outside the designated facilities, the devastation of natural objects by carving out inscriptions do not facilitate the implementation of this task. A large number of visitors in a protected area exposes it to destruction, becoming a reason for the increasing devastation of the natural resources of such areas.

Making national parks available to the public generates significant revenues from business activities. Ticket fees make up for a third of the total revenues from economic activity and nearly 13% of the total budgets of national parks. Understandably, these revenues are varied in each of the parks. The most popular national park in Poland is the Tatra National Park. Entrance fees are 44.4% of its total revenue (Pater, 2018).

The possibility of charging admission fees is addressed in Article 12.3 and 4 of the Act on Nature Conservation and in the Regulation of the Minister of the Environment of 2013. The law, however, is not quite clear on this issue, because it does not specify whether and where entrance fees are mandatory. Article 12 item 3 of the Act indicates that entry can be paid, and in item 10, a requirement is stated for the Minister of the Environment to issue a special regulation concerning some of the parks or areas within them where charges are to be charged. There are, however, parks, for example, the Stołowe Mountains National Park, in which fees are charged for admission (two sites: Szczeliniec Wielki and Błędne Skały), although they are not mentioned in the regulation. A legal basis for tolling is indicated Article 12 item 3 of the Act Nature Conservation, providing the possibility of tolling (Regulation of the Minister of Environment of 18 March 2013; NIK, 2014; Radecki, 2012). The Act indicates that the upper limit of the fee for one-time entry to a national park is PLN 6 (adjusted for inflation), additionally, the director is obliged to exempt children under 7 years of age, persons conducting scientific research in the field of nature protection, pupils and students taking part in classes, inhabitants of the communes and adjacent to the park, persons going to places of religious worship and to beachgoers from the fee. A 50% discount for a ticket should be provided to students, pensioners, disabled persons and soldiers in active service (Act of 16 April 2004, Article 12 item 5, 7, 8).

Data sources and methods

The study included all the National Parks in Poland, with particular focus on the Tatra National Park. Annual data from studies on tourism in national parks, made available by the Central Statistical Office (GUS) in studies entitled *Ochrona Środowiska* (Environmental Protection) for 2005-2018, containing data for 2004-2017, were used. These data were used to show the changes in the volume of tourist traffic, its dynamics and structure. Data were also obtained from the Tatra National Park. They concerned the number of daily ticket sales. However, due to the underestimation for non-ticketed entries, data with a higher degree of aggregation (monthly and annual) plus non-ticketed entries were used for the years 2013-2018.

The annual data on the number of entries to the Tatra National Park [TPN] was analyzed on a trend basis. The resulting time series is characterized by a steady upward linear trend. The linear model expressing the trend is (Aczel, Sounderpandian, 2018, p. 796):

$$Z_t = \beta_0 + \beta_{1t} + a_t, \tag{1}$$

where: t – time, t_a – random error, the coefficients β_0 and β_{1t} are, respectively, the intersection of the vertical axis and the slope of the regression function. The equation of simple linear regression is matched to the data by the method of least squares. Estimation of seasonal fluctuations was carried out using the additive model. Its general formula has the following form (Aczel, Sounder-pandian, 2018, p. 805):

$$Z_t = T_t + S_t + C_t + I_t,\qquad(2)$$

where: T is the trend-cycle component, S is the seasonal component, C is a calendar component, and I is the irregular component. In order to eliminate trend *centred moving average* have been used (due to the very low coefficient of determination for the linear regression model for monthly data) The raw absolute level of seasonal fluctuations is calculated as the sum of differences between empirical values and the corresponding moving average values divided by the number of subperiods in an aligned series. If the sum of the calculated raw levels of seasonal fluctuations is different from zero, a correction factor should be entered, so we get cleansed absolute levels of seasonal fluctuations (Sobczyk, 2010, p. 197).

For monthly data on the number of entries to the TPN, relative and absolute increments, as well as dynamic indices, were calculated.

Tourist traffic in national parks in Poland in 2004-2017

In the national parks, tourist traffic is channelled, entrance is allowed only to designated hiking trails, educational trails, walking paths, public roads and other accessible areas. Tourists can visit the parks using hiking trails with a length ranging from 16.7 km in the Warta River National Park to 550 km in the Kampinoski National Park. In the analyzed period, the number of visitors to national parks in Poland exceeded 10 million annually. In 2004, national parks were visited by 10.4 million tourists, and in 2017, there were already 13.3 million visitors, which is an increase of 27.4%. In 2015, the number of visitors to national parks exceeded 12 million and had increased since then (figure 1).

In 2017 compared to 2016, tourist attendance increased by 3%. The observed increase in attendance results not only from the increase in the pressure of tourists on national parks but also from a more careful recording of the number of visitors. The number of tourists is estimated on the basis of the number of tickets and booklets sold, the number of cars parked in the car parks and direct counting of people crossing entrances to the park. In some parks, e.g. Karkonosze and Warta River, electronic sensors have been installed

to monitor tourist traffic (NIK, 2014, p. 35). Despite this, it seems that the number of tourists visiting national parks in Poland has not been thoroughly estimated. The number of tourists and the dynamics of tourism in the parks is presented in table 1.
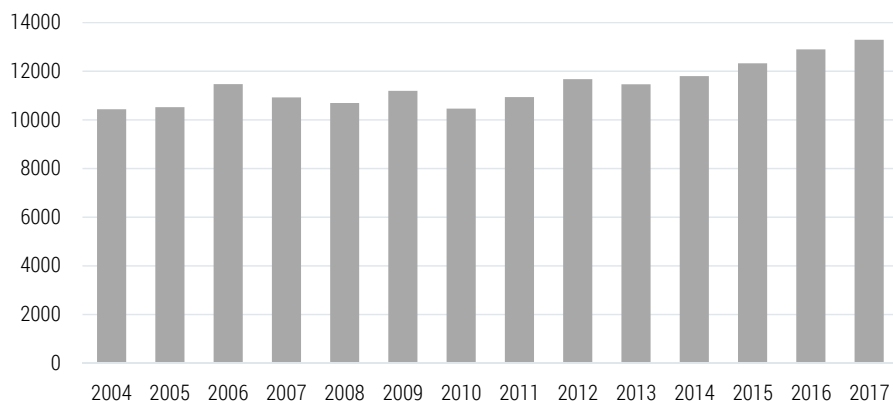
Figure 1. Diagram for the number of tourists in national parks in the years 2004-2017 [in thous.]

Source: author's work based on the GUS data.

Table 1. The number of tourists in national parks in Poland in the years 2004-2017

National park	No. of tourists [in thous.]			Growth rate (2017)		Structure 2017 [in %]
	2004	2016	2017	Id, t_0=2004	Id, t_0=2016	
Babia Góra	70	114	83.3	119	73.1	0.6
Białowieża	220	163.4	248.7	113	152.2	1.9
Biebrza	33.3	41	46.7	140.3	113.9	0.4
Bieszczady	215	487	513	238.6	105.3	3.9
Bory Tucholskie	20	34.5	31.8	158.9	92.1	0.2
Drawa River	11.3	16	13	115	81.3	0.1
Gorczański	50	80	90	180	112.5	0.7
Stołowe Mountains	349	286	515	147.56	180.1	3.9
Kampinoski	1,000	1,000	1,000	100	100	7.5
Karkonosze	1,500	2,000	2,000	133.3	100	15
Magurski	58	50	50	86.2	100	0.4
Narew	4.9	20	19	387.8	95	0.1

National park	No. of tourists [in thous.]			Growth rate (2017)		Structure 2017 [in %]
	2004	2016	2017	Id, t_0=2004	Id, t_0=2016	
Ojcowski	350	428	430	122.9	100.5	3.2
Pieniny	700	931	898	128.3	96.5	6.8
Poleski	14.7	44	49	333.3	111.4	0.4
Roztocze	80	186.7	203.4	254.2	108.9	1.5
Słowiński	182.2	323.4	317.2	174.1	98.1	2.4
Świętokrzyski	195	144	144	73.9	100	1.1
Tatra	2,662	3,683.1	3,779.2	141.9	102.6	28.4
Warta River	20	43.2	34.4	172.0	79.6	0.3
Wielkopolski	1,200	1,200	1,200	100.0	100	9
Wigry	100	125	125	125.0	100	0.9
Wolin	1,400	1,500	1,500	107.1	100	11.3
Total	10,435.4	12,900.3	13,290.6	127.4	103	100

Source: author's work based on Ochrona środowiska 2005, p. 272; Ochrona środowiska 2016, p. 269; Ochrona środowiska 2018, Section 5, tabl. 4(163).

Parks in the mountains are the most popular with tourists: the Tatra National Park (3,779.2 thousand), and Karkonosze (2,000 thousand); ones at the seaside: Wolin (1,500 thousand); as are ones located near big cities: Wielkopolski (1,200 thousand) and Kampinoski (1,000 thousand). In 2017, the smallest number of tourists was recorded in the Drawa River (13 thousand) and Narew River (19 thousand) national parks. Interestingly, the Narew River National Park, despite the low turnout, noted a record, almost fourfold increase in the number of tourists in 2004-2017. Nevertheless, its share in the number of tourists visiting national parks, in general, is almost imperceptible, and stands at 0.1%. What is surprising is the low share of the Białowieża and Babia Góra national parks in the total number of tourists. The Babia Góra National Park is highly popular, located not far from Kraków, and a well-known destination for day trips to admire the sunrise on Babia Góra. Yet, the number of visitors is estimated at only 83.3 thousand in 2017, which is only 0.6% in the tourist structure of national parks in 2017. However, in 2016 compared to 2017, the number of tourists fell by 36.9%. Nevertheless, the data for the years 2004–2017 shows that the year 2016 was the record year for park attendance. In other years, the number of tourists ranged from 52 to 83.3 thousand of tourists annually. Meanwhile, the Białowieża National

Park, the crown jewel in the Polish national parks and a World Heritage site have only a 1.9% share in the structure of tourism in 2017. This small popularity, compared to other national parks, turns out to be surprising given the natural resources protected there. It is worth mentioning its history as the Tsars' hunting grounds, and Nazi attempts to destroy these natural treasures. It should be noted that an increase in the number of tourists in the Białowieża National Park was noted in 2017 compared to 2016 by as much as 52.2%. The Tatra National Park has enjoyed record popularity, and not only did it see a big upsurge of interest in 2004–2017 by 41.9%, but even in 2017 compared to 2016 by another 2.6%. In 2017, it was visited by nearly 4 million people.

Table 2. Hiking trails in the national parks in Poland in the years 2004-2017

National park	Trails in general [in km]		Growth rate (2017)	Number of tourists per 1 ha	Number of tourists per 1 km of trail
	2004	2017	id, t_0=2004	2017	
Babia Góra	53	55	103.8	24.5	1,514.6
Białowieża	38.5	44.3	115.1	23.7	5,613.3
Biebrza	431.8	498.9	115.5	0.8	93.6
Bieszczady	206	465	225.7	17.5	1,103.2
Bory Tucholskie	108.5	93	85.7	6.9	341.6
Drawa River	77	241.3	313.4	1.1	53.9
Gorczański	66.5	169	254.1	12.9	532.5
Stołowe Mountains	161.8	109	67.4	82	4,724.8
Kampinoski	360	550	152.8	29.5	1,818.2
Karkonosze	117.6	125.9	107.1	336	15,885.6
Magurski	85	94	110.6	2.6	531.9
Narew	0.6	54	9000	0.4	351.9
Ojcowski	23	37.4	162.6	199.5	11,497.3
Pieniny	34.7	35	100.9	379	25,657.1
Poleski	35	127	362.8	5.0	385.8
Roztocze	60.3	29.3	48.6	24	6,940.6
Słowiński	144.3	165.7	114.8	14.7	1,914.3
Świętokrzyski	41	41	100	18.9	3,512.2
Tatra	245	275	112.2	178	13,742.6
Warta River	12.6	16.7	132.5	4.3	2,059.9

National park	Trails in general [in km]		Growth rate (2017)	Number of tourists per 1 ha	Number of tourists per 1 km of trail
	2004	2017	id, t_0=2004		2017
Wielkopolski	87.5	233	266.3	158	5,150.2
Wigry	218	272.6	125.0	8.3	458.5
Wolin	44	50.1	113.9	137	29,940.1
Total	2,651.7	3,782.2	142.6	1,664.5	3,514

Source: author's own work based on Ochrona środowiska 2005, p. 272; Ochrona środowiska 2016, p. 269; Ochrona środowiska 2018, Section 5, tabl. 4(163).

In 2004-2017, 20 out of the national parks 23 expanded their networks of hiking trails (table 2). Due to the fact that according to the law tourists can only walk along designated hiking trails, annual congestion is well-illustrated by the number of tourists per 1 km of trail. Given the length of the hiking trails, the most frequented routes were found in the Wolin National Park (29,940.1 pers./km) and the Pieniny National Park (25,657.1 pers./km). Other highly crowded trails are found in the Karkonosze National Park (15,885.6 pers./km), the Tatra National Park (13,742.6 pers./km) and the Ojcowski National Park (11,497.3 pers./km). The least frequented trails included the Biebrza River National Park (78.7 pers./km) and the Drawa River National Park (91.2 pers./km). The data presented in table 2 are annual data, which means that in the months of peak season density of tourists on the trails is much greater.

The annual density of tourists per hectare of the park is also an interesting indicator. It allows you to observe tourist pressure and compare its strength in the individual parks. It should be remembered that this is an illustration indicator only because not all of the park areas are available for tourism, but it shows the tourist pressure on the park area during the year. GUS data from 2017 show (table 2) that the highest density of tourists in relation to the park area was recorded in the Pieniny National Park (379 pers./ha), the Karkonosze National Park (366 pers./ha), and the smallest of the Polish national parks – Ojcowski (199.5 pers/ha). The lowest density was noted in the Narew River National Park (0.4 pers./ha), the Biebrza River National Park (0.8 pers./ha), and the Drawa River National Park (1.1 pers./ha).

Results of the tourist traffic research in the Tatra National Park in 2013-2018

According to the Tatra National Park data, in 2018, nearly 4 million people visited the park. Determining the number of tourists is not easy as there are several ways to get to the park. The number of visitors is determined on the basis of the number of tickets sold by TPN (both at points of sale and e-tickets), the number of tickets for entering the Kasprowy Wierch by cable car and the number of tickets sold at the entrance to the Chochołowska Valley and the Lejowa Valley (these data come from the Forest Community of the 8 Eligible Villages in Witów, which charges fees at this point). In addition to these data, the Tatra National Park assesses the annual number of free of charge entries including:

- entries outside the periods of operation of the ticket sales points (1.5% of the total number of tickets sold),
- entries by residents and other persons exempt from fees (based on the CCTV operating by agents),
- free of charge entries 3% (entries to the TPN in places where there are no ticket sales points and intentional bypasses),
- entries by hostel residents (TPN estimates are based on the numbers of people buying single entrance ticket to the park and staying in the park for more than 1 day),
- Large Family Card entries,
- ski touring entries (based on CCTV input).

The Tatra National Park is the most visited park in Poland, and its popularity among tourists is constantly growing. In comparison with 2013 the number of tourists increased by 1,028 thousand, giving an increase of 35% in just 5 years. To evaluate the effect of the passage of time on the number of tourists visiting the TPN, a linear regression model is used. As shown in table 3 from year to year, the number of tourists increases an average of 216 thousand people. It is worth paying attention to a very high value of R^2. It says that up to 98% of the number of tourists visiting the TPN variation can be explained by the passage of time. This indicates a very good fit of the model to the actual data.

Tourist arrivals to the TPN are varied during the year. Over the whole period covering the years 2013-2018 most visits in the Park took place in August. In 2018, as many as 820 thousand visitors were noted, which gives an average of 26.5 thousand tourists a day. The analysis of entrances on a daily level shows that park entrances are also differentiated according to the day of the week. The most entrances occur on weekends. For years, the

busiest time in August has been around the bank holiday of 15 August,[1] especially if this day is near the beginning or end of the week, resulting in a so-called long weekend. Despite the growing number of tourists in the park, when it comes to August, the highest number of visitors to the TPN was recorded in August 2016 (895 thousand tourists). The number of tourists visiting the TPN on a monthly basis is shown in figure 2.

Table 3. Assessment of parameters of the linear model describing entries to the Tatra National Park

Specification	Parameter	Standard error	Statistics t	p-value
Constant	2,713,952	59776.45	45.4017	0.000001
Time	215,615	15349.17	14.0473	0.000149

R= 0.9900 R^2=0.9801 Corr. R2= 0.9752 F(1,4)=197.33 p<0.00015

Source: author's work.
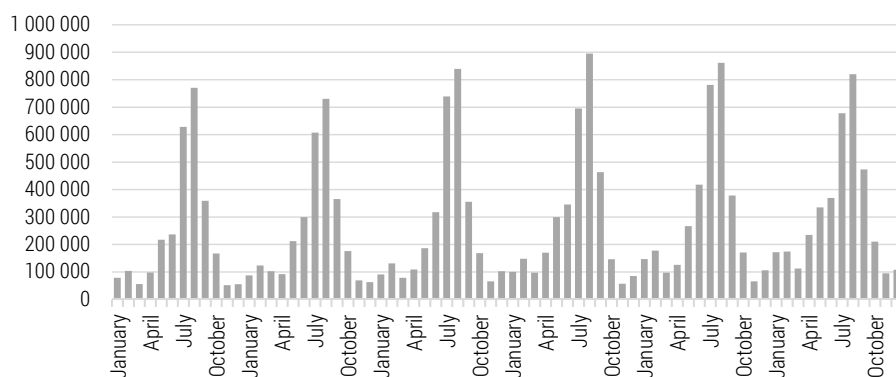
Figure 2. Number of monthly entries to the Tatra National Park in the years 2013 to 2018
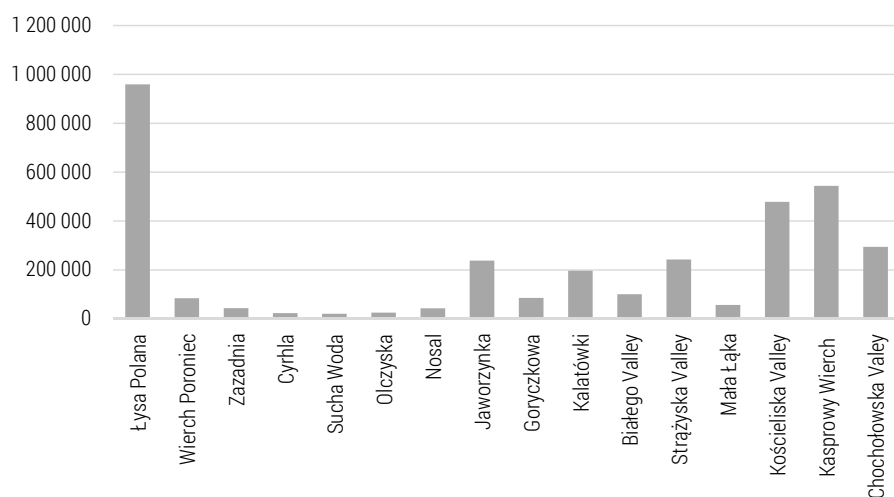
Source: author's work.

The analysis of figure 2 shows that the number of visits in April (increase by 140% in 2018 compared to 2013) and January (increase by 119% compared to 2013) has been the largest in the period under review. The increase in the number of January arrivals is associated with, among other things, the popularization of ski touring, while April entries means that more and more people come to Zakopane and the surrounding area every year to spend

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[1]   In Poland, August 15 is a bank holiday because of a double holiday, civil one, which is the Polish Army Day and a religious one, which is the Assumption of the Blessed Virgin Mary.

Easter there (the figure shows an increase in March or April depending on the month in which that holiday fell in a given year). Interestingly, a strong increase in the number of visitors to the TPN was also noted in November and December (an increase of 84% and 95% respectively in 2018, compared to November and December in 2013). While in December the increase in the number of tourist entries can be associated with Christmas, New Year's Eve and the beginning of the ski tourist season (1,874 such entries to the TPN were recorded in December 2018), the increase in the interest in mountain trips in November can only be explained by the popularization of hiking and love for the mountains.

The lowest growth was observed in the summer vacation season (8% growth in July 2018 compared to July 2013 and 6% in August 2018 compared to August 2013). This is due to limited accommodation, road and parking infrastructure and a large number of tourists on the trails, especially easy ones that do not require advanced skills and equipment.

The number of entries to the Tatra National Park is also geographically diversified. Figure 2 shows the number of tickets sold per year at each toll station. The presented data do not include seven-day tickets and electronic tickets due to the impossibility of their geographical allocation.

Figure 3. The annual number of tickets sold at various entry points to the TPN in 2018

Source: author's work.

The above figure clearly shows that almost 70% of the tickets are sold at the TPN's four ticket sales points: Łysa Polana, Dolina Kościeliska, Dolina Chochołowska and for the Kasprowy Wierch cable car rides. The all-year-round cableway to Kasprowy Wierch transported 544 thousand passengers

in 2018. In the analyzed period, the number of tourists riding to Kasprowy Wierch grew on average by almost 20 thousand every year (Cf. table 4).

Table 4. Evaluation of parameters for the linear model of the number of entrances
to the Tatra National Park in selected points

Specification	Parameter	Standard error	Statistics t	p-value
Kasprowy Wierch				
Constant	422,952.5	10181.17	41.54262	0.000002
Time	19,945.5	2614.28	7.62943	0.001585
R= 0. 9673 R^2=0.9457 Corr. R2= 0,919652 F(1.4)=58,208 p<0,00158				
Łysa Polana*				
Constant	551,386.8	25645.50	21.50033	0.000028
Time	72,810.1	6585.16	11.05669	0.000380
R= 0. 9840 R^2=0.9683 Corr. R2= 0,9604 F(1,4)=122,25 p<0.00038				

* The start of the trail leading to Morskie Oko lake and to the Dolina Pięciu Stawów Polskich valley
Source: author's work.

The distribution of the number of people using the cable cars on a monthly basis is similar to the distribution of the total number of TPN entrances. The highest number of tourists use the cable cars in the summer. In July 2015, almost 105 thousand people took a ride to the peak of Kasprowy Wierch. However, considering the percentage of tickets purchased at the valley station within the number of tickets to the TPN sold in total, the situation is different, as figure 4 shows.
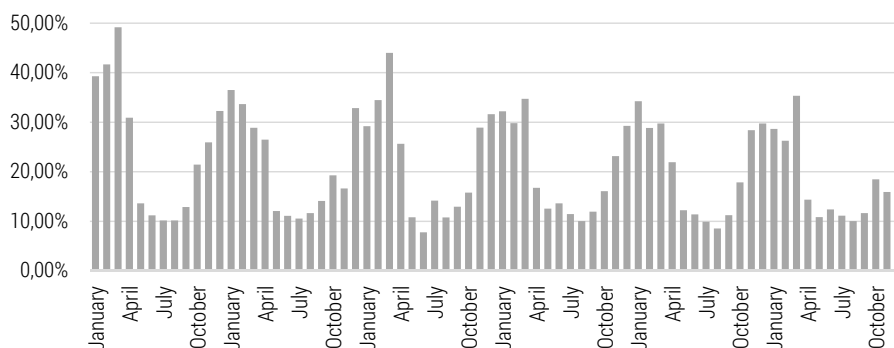
Figure 4. The share of the number of tickets sold at the sales point at Kasprowy Wierch
in the number of entries to the Tatra National Park in total

Source: author's work.

The largest percentage of tourists enter the Park using cable cars in winter. In the 2017/18 season from December to March, tourists using the cable cars constituted 26% to 35% of all entries to the TPN. For comparison, in the summer season of 2018, this percentage constituted 10-11%. The reasons for this should be attributed to several factors. First of all, in the summer season, the total number of tourists is much higher than in the winter season, which results in a smaller percentage of people riding to the peak, even at high absolute values. Secondly, two beautiful alpine ski slopes begin at Kasprowy Wierch, therefore many tourists visit the Park just to practice downhill skiing, and the cable car is the easiest way to get to the top.

Access to data regarding the number of entries to TPN on a monthly basis has allowed the decomposition of time series and estimation of seasonality indicators. Cleansed levels of seasonal fluctuations in the number of tourists visiting TPN in total and in selected points are presented in table 5.

Table 5. Cleansed absolute levels of seasonal fluctuations in the total number of tourists visiting TPN and the number of tourists registered in Łysa Polana and Kasprowy Wierch

Specification	Total	Łysa Polana	Kasprowy Wierch
January	11 035	1 714	4 629
February	30 129	8 551	9 540
March	-48 115	-13 087	-2 648
April	-41 666	-17 281	-4 499
May	-25 132	-1 257	-7 580
June	-106 888	-23 640	-12 908
July	146 724	32 535	17 931
August	279 619	69 658	21 995
September	-43 508	-9 084	-3 246
October	-100 166	-23 377	-6 160
November	-78 688	-19 976	-13 338
December	-23 344	-4 757	-3 717

Source: the author's work.

The greatest impact of seasonality was observed in August. The number of tourists visiting TPN in August was higher than the level resulting from the trend by almost 280,000. As a result of seasonality, almost 70,000 more tourists passed through the gateway in Łysa Polana than the trend level showed,

and 22,000 more tourists visited Kasprowy Wierch. Positive seasonality indicators are also observed for July, January and February, which coincides in time with summer and winter school holidays. In the remaining months, the number of TPN visitors is lower than the level resulting from the trend.

The distribution of the number of entries in each month is similar to the total number of entries in most of the entry points to the Tatra National Park. However, an interesting anomaly here is the Chochołowska Valley, for which in recent years the distribution of the number of entries on a monthly basis can be described as bimodal. Special interest in this valley increases in the spring. In April 2018, the number of tickets sold to the Chochołowska Valley was 58,000, while in July it was 44,000, and in August – 55,000 (with the annual traffic amounting to 294,000). The reason for this situation is a fad to take one's photos against the background of crocuses which bloom in large numbers in this area just around April. These flowers bloom, of course, also in many other places in the Tatras, but it is the Chochołowska Valley that has become the "crocus Mecca" of tourists in recent years.
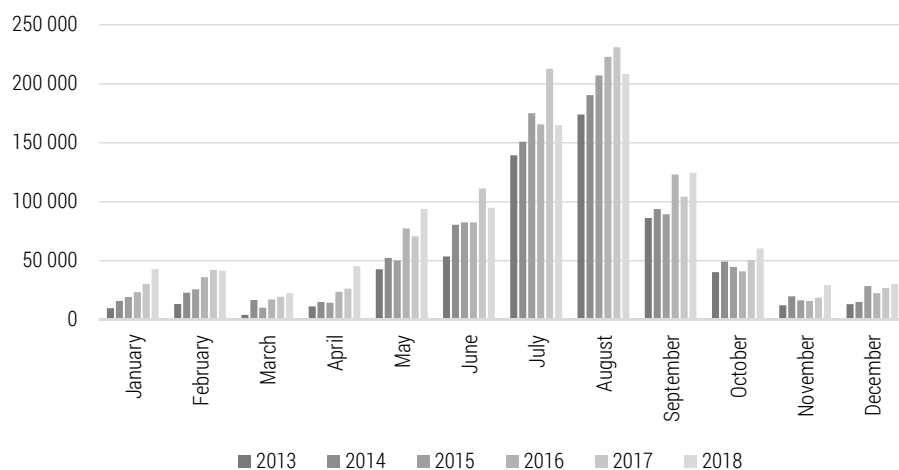
Figure 5. Number of entries to the TPN in Łysa Polana in individual months during the years 2013 to 2018

Source: author's work.

Finally, the gateway to the Tatra National Park must be mentioned through which the largest number of tourists pass every year: the toll point in Łysa Polana. This is where the trail to the Morskie Oko lake and to the Valley of the Five Polish Lakes begins. In 2018, 959 thousand people bought entrance tickets to the Park in Łysa Polana, 208 thousand of them in August. This means that on an average August day there were about 6.7 thousand

people on the road from Palenica Białczańska to the Wodogrzmoty Mickiewicza waterfall (the common part of both trails). This applies only to the tourists who have bought traditional tickets, not counting those who enter with the Large Family Card, those who are exempt from fees, those who have bought seven-day tickets, and so on. As can be seen in Table 4, in the period 2013-2018, the number of tourists entering the Park in Łysa Polana grew year on year by an average of 72.8 thousand annually. The exact number of entries in each month of the period is shown in figure 5.

As can be seen in Figure 5, the increase in the number of entries to the Park in Łysa Polana in the studied period applies to all months, with the largest absolute increase in the number of entries in 2018 recorded in May (increase by 51 thousand compared to May 2013) and the smallest in November (increase by 17.1 thousand compared to November 2013) to December (increase by 17.3 thousand compared to December 2013). In total, this gives a 60% increase in the number of entries in 2018 compared to 2013. More dynamic growth in the number of entries was recorded only for the Wierch Poroniec toll point (increase by 323% compared to 2013), but it should be remembered that the number of tickets sold there in 2013 amounted to 20 thousand annually.

Conclusions

The analysis shows that tourism in national parks is growing. In the period 2004-2017, a 27% increase in the number of tourists visiting national parks was observed. The highest tourist pressure is on the Tatra National Park, which in 2018 recorded almost 4 million entries. The trail leading along the Dolina Rybiego Potoku valley (road to the Morskie Oko lake), which enjoyed the greatest popularity, has noted record attendance rise, from 23 thousand visitors in March 2018 to 208 thousand in August 2018.

The growing tourist traffic in national parks, on the one hand, significantly supports the budget of these entities and on the other hand, it is a challenge for park managers in terms of the implementation of the parks' protective functions. Traffic control in the Tatra National Park is associated with a particular dilemma. Theoretically, from the legal standpoint, it is possible to take action to reduce the number of tourists coming to the park, however, it would be very difficult (or impossible) from the organizational point of view. Such a regulation would also be met with strong protests from both visitors and residents of the surrounding municipalities who depend on tourism for their livelihoods. For this reason, the Tatra National Park does not take any action to relieve the traffic on the road to Morskie Oko, thus

moving it to other, less frequented areas of the park. From the point of view of nature conservation, a better solution is to concentrate traffic along an asphalt road than disperse such a huge number of tourists across a relatively small area. It is also beneficial from the point of view of mass tourism safety.

Taking into account the growing rise of interest in visiting national parks, it is necessary to discuss the future of tourism in these most valuable natural and landscape sites. Due to the growing interest in areas with special natural values, dilemmas concerning the organization of tourism, which today mainly concern the Tatra National Park may become a challenge for other parks in the near future.

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The contribution of the authors

Małgorzata Ćwiek – 50% (conception, literature review, acquisition of data, analysis and interpretation of data).
Beata Pater – 50% (conception, literature review, acquisition of data, analysis and interpretation of data).

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DISCUSSION
AND REVIEWS

RECENZJE
OMÓWIENIA, PRZEGLĄDY

Ewa LISOWSKA-MIESZKOWSKA

UNECE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION – 40 YEARS OF ACTION FOR CLEANER AIR

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ABSTRACT: November 2019 marked the 40th anniversary of the adoption in Geneva of the Convention on Long-Range Transboundary Air Pollution, which aims primarily to reduce the damage to human health and the environment caused by air pollution. Over the years, the Convention has been extended by eight protocols that identify measures to control emissions of basic air pollutants. The efforts undertaken under the Convention have been instrumental in bolstering international cooperation to limit the pollution with sulphur and nitrogen oxides as well as to reduce emissions of other pollutants. The European Monitoring and Evaluation Programme (EMEP) has been developed complete with modelling and forecasting air pollution levels and pollutant fluxes. Robust information has been gathered in the EMEP databases. However, much remains to be done, and air pollution is still a challenge in the UN ECE region.

KEY WORDS: air pollution, air quality, international legislation, international agreement, regional convention

Introduction

2019 was the 40th anniversary of the adoption of the Convention on Long-range Transboundary Air Pollution (LRTAP Convention) – the first-ever internationally binding agreement addressing the damage to human health and the environment caused by air pollution (UN ECE, 1979). Despite the tense political situation in Europe in the seventies of the 20th century, the Convention set the framework for international cooperation, which was a major step in improving the air quality in the region.

Background of the LRTAP Convention

In the seventies of the 20th century, Europe was mostly concerned with the growing acidification of the environment. The pollutants such as sulphur and nitrogen oxides emitted by the industry, power production and transport were deposited on the ground as acid rain, while the emission source might have been located far from the deposition site, even in a foreign country. Acid rains were responsible for soil and surface water acidification and damage to ecosystems and affected human health, material corrosion, infrastructure and cultural heritage. The Scandinavian countries, where the detrimental effect of environmental acidification was particularly visible, raised this issue at the international level already in 1972 during the United Nations Conference on the Human Environment in Stockholm. In response to these problems, the European Economic Commission, one of the five regional UN commissions, which assembled the European countries, USA, Canada, Israel and the then Soviet Union (and now the majority of the states, which emerged after the collapse of the Soviet Union), initiated actions to achieve multilateral agreement to tackle the issue of air pollution and ever-growing acidification of the environment. These efforts culminated in approving the text of the Convention on Long-range Transboundary Air Pollution, which was adopted in Geneva on November 13, 1979, during a regional meeting on the protection of the environment. It was signed initially by 32 states of the UN ECE region, including Poland.

Goals and commitments

The general aim of the Convention has been and still is to control and reduce the damage to human health and the environment caused by air pollution. In the preamble, the Parties to the Convention emphasize the importance of establishing relations and cooperate to protect the environment and

recognize 'the existence of possible adverse effects, in the short and long-term, of air pollution' (including transboundary air pollution) as well as 'the need to study implications of the long-range transport of air pollutants and the need to seek solutions for the problems identified' (UN ECE, 1979). This means that the Parties to the Convention confirm their willingness to conduct and reinforce active multilateral cooperation to develop appropriate national policies and coordinate nationally undertaken efforts to combat air pollution. The Parties also undertake a commitment to conduct studies and monitoring as well as to exchange information and consultations. It is to be remembered that the text of the Convention was drawn in the seventies of the 20th century when Europe was still divided by the iron curtain and international cooperation was not an obvious thing. The ECE was then principally a unique forum for communication between Western Europe and the USA on one side, and the Eastern Bloc on the other. Thus, there are good reasons to value the cooperation in the past, the more that it yielded such positive results in the field of environmental protection.

The provisions of the Convention are of general nature and commit the Parties to take appropriate measures, among others, to:
- exchange information on and review their policies, scientific activities and technical measures aimed at combating the discharge of air pollutants (Art. 3),
- hold consultations in case of long-range transboundary air pollution episodes (or risk of such pollution episodes) (Art. 5),
- develop policies and strategies, which shall serve as a means of protecting the air quality including the air quality management systems, in particular by using the best available technologies (Art. 6),
- cooperate in the conduct of research (Art. 7),
- exchange available information on emissions data, meteorological, physicochemical and biological data relating to the process of transmission of long-range transboundary air pollution, data on control technologies for reducing air pollution as well as data on significant changes in policies for the air protection (Art. 8).

From the historical viewpoint, a milestone under the Convention was that the Contracting Parties (Art. 9) agreed to implement the 'Cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe' (EMEP), which over the past decades, enabled to establish the scientific base of the Convention. The Parties emphasized their willingness to join in its implementation, i.e. to conduct measurements, use standardized procedures for monitoring and data exchange, monitor the quality of other environmental media, such as water soil and vegetation as well as to develop national networks of EMEP monitoring stations.

Extension of commitments – protocols

The Convention entered into force in 1983 upon ratification by 24 states. Poland has ratified the Convention somewhat later, in 1985 (Journal of Laws 1985). Despite that its text contained no concrete arrangements concerning the emission abatement level (what then provided flexibility and facilitated participation of many countries), the developing cooperation succeeded fairly swiftly in the negotiation of eight subsequent protocols, including:

- Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (European Monitoring and Evaluation Programme, EMEP) (signed in 1984, entered into force in 1988), the so-called EMEP Protocol (UN ECE, 1984),
- Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (signed in 1985, entered into force in 1987), the so-called Sulphur Protocol I (Helsinki Protocol) (UN ECE, 1985),
- Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes (signed in 1988, entered into force in 1991), the so-called Nitrogen Protocol (Sophia Protocol) (UN ECE, 1988),
- Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (signed in 1991, entered into force in 1997), the so-called VOC Protocol (Geneva Protocol) (UN ECE, 1991),
- Protocol on Further Reduction of Sulphur Emissions (signed in 1994, entered into force in 1998), the so-called Sulphur Protocol II (Oslo Protocol) (UN ECE, 1994),
- Protocol on Heavy Metals and its 2012 amended version (signed in Aarhus in 1998, entered into force in 2003) (UN ECE, 1998a),
- Protocol on Persistent Organic Pollutants (POPs) and its 2009 amended version (signed in Aarhus in 1998, entered into force in 2003) (UN ECE, 1998b),
- Protocol to Abate Acidification, Eutrophication and Ground-level Ozone as amended on 4 May 2012 (signed in 1999, entered into force in 2005), the so-called Gothenburg Protocol (UN ECE, 1999).

Importantly, the first of the Protocols was instrumental in providing funds for the aforementioned EMEP study Programme, which aimed at the monitoring of air quality and pollutants fluxes. Owing to subsidies secured under the Protocol, the Programme has been sustainable and, with time, has developed to achieve the present status quo. Over time, this has resulted in a robust collection of information, and the picture of the regional air quality established based on this information could not be easily ignored and encour-

aged further actions. The latter, due to the nature of the problem, could not succeed unless with international cooperation.

The subsequent protocols set real commitments to reducing emissions of particular air pollutants. While the first protocols focused on acidifying pollutants, such as sulphur and nitrogen oxides, the subsequent protocols addressed other long-range airborne compounds, including volatile organic compounds, heavy metals, persistent organic pollutants and ultimately, the entire package of acidifying and eutrophying substances and tropospheric ozone precursors, incorporated in the ultimate protocol. The commitments to reducing the annual pollutant emission, being initially equal for all countries (30% reduction in sulphur oxides, provided for in the historical Sulphur Protocol I), became quickly differentiated depending upon conditions in a given state. As a baseline, the concept of critical loads was adopted, which is defined as the load of a pollutant 'below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge'. Moreover, the results were used of the integrated modelling intensively developed within the framework of the Convention. The assumption was to reach no exceedance of critical load levels by the individual states. Since the adoption of the Sulphur Protocol II, the binding annual emission reduction commitments have been defined as a percentage reduction of the value reported for the baseline year. In the 1999 Gothenburg Protocol, the values of permissible national annual emission (emission ceilings) were expressed as both the absolute values (in thousands of tonnes per year) and as the per cent emission reduction which should be achieved by 2010, compared to 1990 baseline year. The above values varied between states and pollutant types, e.g. they fluctuated between 0% (Armenia) and 90% (Germany) for SO_2. In addition to introducing the permissible national annual emission levels, the protocols have stepwise regulated permissible levels of emission from various categories of stationary and mobile sources, including industries, power generation and transport. Moreover, the contents of some pollutants in the products have been standardized.

The approach of the protocols was that they encourage not only the commitments to controlling and reducing pollutant emissions but also to studying and reporting measurement data collected and formatted with the use of standardized procedures to the research centres under the EMEP Steering Body. This helped to establish a robust database on emissions, which has been used to study, predict and model transboundary pollutant fluxes across the northern hemisphere. Such a development of provisions under the Convention, from those relatively mild and easily acceptable, set by the Convention itself, to the stricter ones, albeit suitably flexible and adjusted to the varying conditions in respective countries, provided for in subsequent proto-

cols, assured a proportionally great number of ratifications and implementations. This made the Convention approach highly effective, in particular concerning sulphur and nitrogen oxides, whose emissions declined significantly in the ECE region over the past 40 years.

The Convention today

At present, Parties to the Convention embrace 50 states (from among 56 ECE member states) and the European Union. The Executive Body is the governing body of the Convention receiving assistance from subsidiary bodies, including:
• Implementation Committee, which tackles the matters of the Parties compliance with the provisions provided for by the Convention and Protocols,
• Working Group on Strategies and Review (WGSR),
• Working Group on Effects (WGE),
• EMEP Steering Body.

The Working Group on Strategies and Review receives reports from two Task Forces: on Techno-Economic Issues and Reactive Nitrogen, while the Working Group on Effects supervises six International Cooperation Programmes (ICPs) together with their task forces and programme centres – whose responsibility includes the integrated monitoring of air pollution, its modelling and mapping as well as pollutant impacts on waters, forests, vegetation, plantations, materials and cultural heritage.

Here belongs also the working group shared with WHO, which tackles the human health aspects of air pollution as well as an expert group for dynamic modelling, which has developed into the Centre of Dynamic Modelling since January 1st 2020. Five different research Centres operate within EMEP, which are responsible for emission inventory, modelling and forecasting, in addition to four Task Forces providing fora for discussion and scientific exchange. The Executive Body is also in charge of the Coordination Group, whose task is to develop coordination and provide support for states of Eastern Europe, Caucasus and Central Asia (EECCA).

The last three of the abovementioned protocols are of special importance now, even if the Protocols on heavy metals and POPs have lost some momentum following the adoption and entry into force of the global agreements, including 2004 Stockholm Convention on persistent organic pollutants (UNEP, 2018) and 2017 Minamata Convention on mercury (UNEP, 2019). Whereas, the Gothenburg Protocol has a high status, since it regulates a wide spectrum of issues, from the permissible levels of annual emission of basic

pollutants such as sulphur and nitrogen oxides, non-methane volatile organic compounds and ammonia, to the emission standards for numerous stationery and mobile pollution sources along with the fuel quality requirements, to the best available techniques to keep down the ammonia emission from agriculture (UN ECE, 1999).

The Protocol was amended following a long negotiation process in 2012, to include new tighter reduction targets for sulphur and nitrogen oxides, ammonia and non-methane volatile organic compounds (NMVOC) to be achieved by 2020 and beyond, and the reduction targets for the new compound – particulate matter PM 2.5. New standards were set for the content of NMVOCs in products and new limit values for specific emission sources, both stationary and mobile. The amendments entered into force in 2019, while the European Union adopted them already in 2017 (the EU is Party to the Protocol). These reduction targets were earlier still, in 2016, the base for setting tighter requirements in the EU Directive 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (EU, 2016). Thus, all the EU Member States have now the obligation to achieve the reduction targets, including those States, like Poland, which has not yet ratified the Gothenburg Protocol.

After a prolonged debate, it was agreed that the Convention should not be extended to include states outside the UN ECE. That notwithstanding, the scope of cooperation has been broadened to embrace other regions of the world and international organizations, in particular, WHO and WMO. Given the effective procedures and instruments designed under the Convention, it has become an exemplary precedent, which is now being followed by, e.g. Asian states.

Achievements

In the UN ECE region, the adoption of the Convention was crucial for initiating international cooperation, which was quite an issue at that time. This contributed to the development of air pollution abatement policies and thus, to a significant decrease in the emission of air pollutants, in particular of sulphur oxides. The scientific report established in 2016, at the request of the Executive Body, summarizing the Convention achievements to date (Maas, 2016), acknowledged that the total annual emission from the Convention Member States declined by more than 60% for SO_2 and by ca. 40% for NOx between the years 1990-2010. In the case of ammonia, particulate matter PM2.5 and NMVOC, there was also a decline, but much lower, whereby this decline was especially visible in the initial period of the Convention.

The Convention pioneered in regulating the emission of heavy metals and persistent organic pollutants. The report mentioned above acknowledged that the measures designed under the Convention significantly reduced acidification threats to forest and aquatic ecosystems and prevented 600,000 premature deaths annually in the UN ECE region. Nevertheless, air pollution is still considered the cause of many premature deaths.

Under the Convention, a unique approach was adopted to the air pollution issue, which was conceived as an 'effect-oriented' approach, developed to assess the air pollution effects considering its environmental consequences, based on critical loads and levels. The latter is understood as thresholds for pollutant loads, below which no harmful effects are expected to occur in the environment while taking simultaneously into account multiple pollutants and their possible impacts and inter-relationships (multi-pollutant multi-effect approach).

The efforts under the Convention were instrumental in the development of scientific knowledge and numerous databases. A vast amount of data has been collected under the EMEP programme, both imission data from monitoring and emission data from reporting, and the data quality has been systematically improving.

Technical and scientific reports have been published annually, while the knowledge database on pollutant monitoring, emission, effects and migration as well as on emission reduction techniques and costs has been continuously extended and updated. Likewise, integrated modelling and predicting potential have been advancing. The members of task forces contribute to developing manuals, guidelines and guidebooks, such as the 'EMEP/EEA air pollutant emission inventory guidebook' (EEA Report 13/2019), which has been constantly updated and applied for reporting under the NEC Directive as well, or the 'Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions' (UN ECE, 2015), developed by the Task Force on Reactive Nitrogen as a base to prepare national codes of good practice.

Moreover, legislative arrangements, which have been developed under the Convention, allow for a flexible approach to the implementation of its provisions and a stepwise fulfilment of commitments. This is important when ratifying the Convention and has special significance for the states from the EECCA region. Both the way the Convention functions and the legislative solutions applied have been considered as exemplary for other agreements and regions of the world.

Future challenges

The abovementioned achievements, however, do not grant that the issue of excessive air pollution in the UN ECE region has been solved. Contrastingly, a distinct decelerating trend was observed for the decline of the monitored air pollutant values, and presently, one cannot reasonably expect such spectacular effects of the Convention, as it was in the nineties of the 20th century. Further reduction of emissions becomes more difficult and costly for the states of the UN ECE region, including the European Union, the more so that the sectors posing the greatest threat to the air quality include, among others, agriculture, food industries and household heating. Further reduction of emissions in these sectors requires not only increased investments and introduction of best available technologies but also changes of the consumers' lifestyles, diet and habits. The latter seems to be much more challenging to be regulated with legal provisions and standards.

The newest report concerning the emissions inventory within the European Union published by the European Environment Agency (EEA Report No 08/2019) states that more than half of the 26 pollutant emissions monitored within the UE have slightly grown up in 2017 as compared to the preceding year. Declining trends are still valid for the emissions of sulphur and nitrogen oxides, whereby the latter poses a serious problem due to disruptions of the global nitrogen cycle and detrimental effects in humans and the environment. On the other hand, the emissions of NMVOCs, certain POPs, heavy metals and ammonia have increased. The growing emission of ammonia is especially challenging for the EU, since in the years 1990-2017, the percent decrease for this emission was significantly lower than for other pollutants, while in 2014-2017 it increased by 2.5% (EEA, 2019).

The new Long-term strategy for the Convention on Long-range Transboundary Air Pollution adopted in 2018 (ECE/EB.AIR/142/Add.2) addresses the following most important future challenges:

- Reduction in the emission of particulate matter, including black carbon, and precursors of secondary particulate matter – given their significant health effect in terms of human morbidity and mortality as well as the detrimental impact on the environment (acidification, salinization) and materials (corrosion),
- Reduction in the emission of tropospheric ozone precursors, including methane – given the damaging effect of ozone on ecosystems, and on vegetation in particular, and considering the predicted renewed growth of the atmospheric ozone concentrations in the years 2020-2030,
- Solving the problem of nitrogen cycle disruption in the environment and the excessive emission of nitrogen compounds (especially of ammonia)

– given the growing eutrophication and disruption of global and regional nitrogen cycles.

Other significant priorities under the Strategy involve further study on the effects of air pollutants and their interactions with ecosystem functioning and climate change, in addition to the development of air quality monitoring, pollutant impact evaluation and modelling. The important tasks envisaged by the Strategy embrace studies on the effect of the hemispheric and regional pollution levels on the local air quality, especially in urban areas as well as studies on synergy and effectiveness of mitigation efforts undertaken at various scales.

The increase in ratification numbers is of vital importance, in particular as concerns the three last protocols (especially among the EECCA states, with which intensive talks are held, supported by advisory meetings and workshops) as well as the development, under the Convention, of broad cooperation with organisations, institutions and initiatives dealing with similar issues. To support these efforts, a new initiative was launched – the Forum for International Cooperation on Air Pollution. When it comes to further tightening of commitments provided for in the protocols to the Convention, the work has been already initiated to develop a successive update to the Gothenburg Protocol, which shall regulate emissions of black carbon and methane as well as the emission from marine shipping.

Concluding remarks

Despite the lapse of time, the LRTAP Convention remains the most important regional agreement on controlling and reducing the damage to human health and the environment caused by transboundary air pollution. The agreement has been evolving over the past four decades and has thus maintained the form, which fits in the present reality, even more, it has been considered as a landmark example to inspire regional solutions elsewhere. However, financial support for activities under the Convention remains a permanent problem, while there are still many challenges ahead.

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SUMMARIES
IN POLISH

Agnieszka BECLA • Stanisław CZAJA

DYLEMATY SPOŁECZEŃSTWA INFORMACYJNEGO I WYZWANIA ROZWOJU ODPOWIEDZIALNEGO

STRESZCZENIE: Społeczeństwo informacyjne i gospodarka oparta na wiedzy to pożądany kierunek przemian cywilizacyjnych. Może bowiem prowadzić do rozwoju odpowiedzialnego i gospodarki opartej na mądrości. Generuje to jednak określone niedoskonałości i bariery. Ich identyfikacja oraz ograniczanie jest warunkiem odpowiedzialnego rozwoju w przyszłości. Autorzy zwrócili uwagę na kilka ważnych tego typu zagrożeń dla przyszłości społeczeństwa informacyjnego i towarzyszącej mu gospodarki.

SŁOWA KLUCZOWE: społeczeństwo informacyjne, gospodarka oparta na wiedzy, gospodarka oparta na mądrości, odpowiedzialny rozwój

Justyna GODAWSKA

EFEKT RAMOWANIA A POPARCIE PUBLICZNE DLA POLITYKI ŚRODOWISKOWEJ

STRESZCZENIE: Efekt ramowania polega na tym, że sposób, w jaki pewien problem jest przedstawiony (ramowany) wpływa na percepcję tego problemu przez osobę podejmującą decyzję i jej preferencje. Opinia publiczna odnośnie polityki środowiskowej może się różnić w zależności od tego, jak cele i skutki poszczególnych działań lub instrumentów w ramach tej polityki są scharakteryzowane. Celem artykułu jest zbadanie wpływu alternatywnych sposobów ramowania problemu zanieczyszczenia SO_2 (konsekwencje dla ludzkiego zdrowia, przyrody i finansów państwa) na poparcie społeczne dla polityki ograniczania tego zanieczyszczenia (opłat emisyjnych i handlu emisjami) oraz ponoszenia wyższych kosztów ogrzewania. W badaniach wykorzystano eksperyment, w którym uczestniczyli studenci, a wyniki analizowano przy wykorzystaniu testu t do porównania średnich. Wyniki wskazują, że podkreślanie wpływu szkodliwego dla środowiska zachowania dla ludzkiego zdrowia może zwiększyć społeczne poparcie dla wprowadzenia instrumentów polityki środowiskowej i zachęcić do dobrowolnych działań mających na celu ochronę środowiska.

SŁOWA KLUCZOWE: ekonomia behawioralna, polityka środowiskowa, efekt ramowania

Piotr BOŁTRYK

PRZEKSZTAŁCANIE GRUNTÓW ROLNYCH NA CELE NIEROLNICZE W POLSCE

STRESZCZENIE: Podstawowym celem pracy jest przedstawienie procedur prawnych związanych z przekształcaniem gruntów rolnych na cele nierolnicze w Polsce. Na podstawie analizy obowiązujących regulacji prawnych wskazano i opisano czynności, jakie należy podjąć, aby móc rozpocząć nierolnicze użytkowanie gruntu. Omówiono zarówno zmianę przeznaczenia gruntów, jak również wyłączenie gruntów z produkcji rolnej. Interpretacja wybranych przepisów prawa umożliwiła uporządkowanie procedury przekształcania gruntów rolnych na cele nierolnicze. Dodatkowo, na podstawie wybranych danych statystycznych, aspekt prawny uzupełniono informacjami na temat aktualnego poziomu „odralniania" gruntów w Polsce.

SŁOWA KLUCZOWE: grunty rolne, zmiana, przeznaczenie

Mirosława WITKOWSKA-DĄBROWSKA · Agnieszka NAPIÓRKOWSKA-BARYŁA · Natalia ŚWIDYŃSKA

HARMONIZACJA KRYTERIÓW I OPERACJONALIZACJA WSKAŹNIKÓW ZRÓWNOWAŻONEGO ROZWOJU W OCENIE BIOPRODUKTÓW

STRESZCZENIE: Artykuł miał na celu wskazanie ścieżki wyboru wskaźników zrównoważonego rozwoju do oceny bioproduktów. Jest próbą wyznaczenia kryteriów operacjonalizacji oceny bioproduktów na podstawie dostępnej literatury przedmiotu oraz opinii przedsiębiorców produkujących opakowania z tworzyw ropopochodnych. Wyniki badań literaturowych oraz ankietowych wskazują, że wskaźniki stosowane do oceny powinny dokładnie odzwierciedlać proces lub stan rzeczy, który prezentują, być zrozumiałe dla każdego interesariusza na całym łańcuchu dostaw.

SŁOWA KLUCZOWE: bioprodukty, ocena, wskaźniki ZR, operacjonalizacja

Urszula MOTOWIDLAK

POTENCJAŁ PRZEDSIĘBIORSTW TRANSPORTU DROGOWEGO W ZAKRESIE WDRAŻANIA DZIAŁAŃ ADAPTACYJNYCH DO ZMIAN KLIMATU

STRESZCZENIE: Ze względu na fakt, że transport ma ogromne znaczenie dla zrównoważonego rozwoju społeczno-gospodarczego, konieczne są działania adaptacyjne mające na celu zwiększenie odporności przedsiębiorstw sektora Transport-Spedycja-Logistyka (TSL) na negatywne skutki zjawisk klimatycznych. Do wdrożenia efektywnych działań adaptacyjnych i zapobiegawczych niezbędne jest zaangażowanie wielu podmiotów i instytucji na poziomie krajowym, regionalnym i lokalnym. Ważną rolę we wdrażaniu tych działań przypisano przedsiębiorstwom transportowym, co stanowiło przedmiot rozważań podjętych w artykule. Na podstawie przeprowadzonego badania ankietowego, wśród celowo wybranej grupy przedsiębiorstw sektora TSL, dokonano oceny świadomości skutków zmian klimatu i konieczności podejmowania działań adaptacyjnych.

SŁOWA KLUCZOWE: transport drogowy, emisje CO_2, zmiany klimatu, adaptacja do zmian klimatu

Adam PAWLICZ • Ana-Marija VRTODUSIC HRGOVIC

PRZESTRZENNE ASPEKTY EKONOMII WSPÓŁDZIELENIA NA RYNKU USŁUG HOTELARSKICH W POLSCE

STRESZCZENIE: Rozwój ekonomii współdzielenia zasadniczo zmienił rynek usług hotelarskich w Polsce i na świecie. Dotychczasowe badania rynku ekonomii współdzielenia nie uwzględniały aspektów przestrzennych rozwoju, zwłaszcza w obszarach nie będących dużymi aglomeracjami. W artykule na podstawie przeglądu literatury zidentyfikowano trzy grupy czynników wpływających na rozwój ekonomii współdzielenia: związane z populacją i urbanizacją, związane z tradycyjną bazą hotelową oraz z atrakcyjnością turystyczną. Badania zrealizowane z wykorzystaniem danych AirDNA i GUS na poziomie powiatów w Polsce wykazały, że liczba ofert ekonomii współdzielenia nie jest silnie skorelowana z populacją i z gęstością zaludnienia, ale liczba ofert per capita jest w miastach na prawach powiatu pięciokrotnie wyższa niż w pozostałych powiatach. Powyższe potwierdza wnioski formułowane w dotychczasowej literaturze przedmiotu. Liczba ofert ekonomii współdzielenia jest również silnie pozytywnie skorelowana z liczbą tradycyjnych obiektów hotelarskich oraz wskaźnikiem atrakcyjności turystycznej a rozwój ekonomii współdzielenia przyczynia się do zwiększenia koncentracji przestrzennej rynku usług hotelarskich w Polsce.

SŁOWA KLUCZOWE: ekonomia współdzielenia, Airbnb, HomeAway, AirDNA, atrakcyjność turystyczna

Walery JEZIERSKI • Beata SADOWSKA

EKONOMICZNE EFEKTY ZMIAN WYMAGANEJ IZOLACYJNOŚCI CIEPLNEJ PRZEGRÓD BUDOWLANYCH W POLSCE

STRESZCZENIE: Ocieplenie przegród zewnętrznych budynków jest bardzo typową strategią zmniejszania zapotrzebowania na energię do ogrzewania. W artykule przedstawiono oryginalne badanie zależności zapotrzebowania na energię użytkową $Q_{H,nd}$ jednorodzinnego budynku mieszkalnego w zróżnicowanych warunkach klimatycznych (łagodniejszych – dla Szczecina, średnich krajowych – dla Łodzi i surowszych – dla Zakopanego) od współczynnika przenikania ciepła wybranych przegród: ścian zewnętrznych, dachu, okien i drzwi balkonowych, okien połaciowych oraz drzwi zewnętrznych, które zostały przyjęte na trzech poziomach odpowiadających maksymalnym dopuszczalnym wartościom, zatwierdzonym w Warunkach Technicznych, obowiązującym od 2014, 2017 i 31.12.2020 roku. Na podstawie wyników eksperymentu obliczeniowego opracowano trzy deterministyczne modele matematyczne tej zależności oraz przeanalizowano efekty wpływu czynników na funkcję Y dla przyjętych warunków klimatycznych. Określono oszczędności finansowe związane z wprowadzeniem surowszych wymagań w zakresie ochrony termicznej budynków w Polsce.

SŁOWA KLUCZOWE: zapotrzebowanie na energię użytkową, warunki klimatyczne, współczynnik przenikania ciepła przegród budynku, deterministyczny model matematyczny, efekt ekonomiczny

Anna STRONCZEK • Łukasz WAKSMUNDZKI

MSGO-ECOTECH SYSTEM JAKO NARZĘDZIE WSPARCIA PRZEDSIĘBIORSTW W REALIZACJI ROZSZERZONEJ ODPOWIEDZIALNOŚCI PRODUCENTA (ROP)

STRESZCZENIE: Celem artykułu jest zademonstrowanie możliwości rozwiązania EcoTech System wspierającego wdrożenie założeń rozszerzonej odpowiedzialności producenta. Metodami badawczymi stosowanymi do osiągnięcia tego celu są studia literaturowe i studium przypadku „MSGO – Eco-Tech System".

Normy unijne nakładają na państwa członkowskie wysoki poziom odzysku i recyklingu. Oczywiste jest, że w celu spełnienia poczucia sprawiedliwości społecznej, ci, którzy bezpośrednio przyczynili się do tej sytuacji, tj. konsumenci i producenci, również powinni wziąć udział w tych procesach. Producenci potrzebują jednak narzędzi do monitorowania wydajności i skuteczności swoich działań. Przedstawiany „MSGO – EcoTech System" bazuje na systemie zachęt. U jego postaw leży założenie, iż firmy, które deklarują w swojej strategii biznesu społeczną odpowiedzialność przyłączą się aktywnie tworząc system zachęt. Przykład pokazuje, ze istnieją nowoczesne rozwiązania, które mogą wspomóc firmy w realizacji EPR. Uzyskane wyniki dostarczają wskazówek dla przedsiębiorstw szukających rozwiązań w tym zakresie.

SŁOWA KLUCZOWE: Rozszerzona Odpowiedzialność Producenta, EPR, odpady, EcoTech System

Eleonora RATOWSKA-DZIOBIAK

ŚWIADOMOŚĆ UBEZPIECZENIOWA W ZAKRESIE RYZYK POGODOWYCH

STRESZCZENIE: Celem artykułu jest ocena zmian zachodzących w świadomości ubezpieczeniowej podmiotów w obszarze ryzyka pogodowego. Przeprowadzone badania wskazują, że z punktu widzenia klienta atrakcyjna cena w połączeniu z kompleksową obsługą odgrywają ważną rolę. Rozmówcy podkreślają, że uwzględnienie nowych zagrożeń oraz dopasowanie oferty do potrzeb nabywcy może istotnie wpływać na wielkość popytu w zakresie usług ubezpieczeniowych. Zainteresowanie wśród konsumentów produktami ochronnymi na wypadek ryzyka pogodowego zależy od zakresu ochrony oraz wysokości składki ubezpieczeniowej, a także od innowacyjnych rozwiązań w sposobie dystrybucji (m.in. system ubezpieczeń wzajemnych).

SŁOWA KLUCZOWE: świadomość ubezpieczeniowa, rynek ubezpieczeń, usługi ubezpieczeniowe, ryzyko pogodowe

Małgorzata ĆWIEK · Beata PATER

RUCH TURYSTYCZNY W PARKACH NARODOWYCH W POLSCE

STRESZCZENIE: Celem artykułu jest ocena wielkości ruchu turystycznego w parkach narodowych w Polsce w latach 2004-2017, ze szczególnym uwzględnieniem parku o najwyższej frekwencji turystycznej – Tatrzańskiego Parku Narodowego (TPN). Szczegółowa analiza ruchu turystycznego w TPN dotyczy okresu 2013-2018. W opracowaniu zbadano dynamikę ruchu turystycznego w parkach a także wielkość, charakter i rozkład przestrzenny ruchu turystycznego w TPN. Ukazano również uwarunkowania zarządzania ruchem turystycznym w parkach narodowych oraz jego znaczenie zarówno dla przyrody, jak i dla budżetu tych jednostek organizacyjnych. Do analizy wykorzystano dane pochodzące z opracowań Głównego Urzędu Statystycznego dotyczących ochrony środowiska oraz danych dotyczących wstępu do Tatrzańskiego Parku Narodowego. Wśród dominujących cech ruchu turystycznego należy wymienić jego dynamiczny wzrost w badanym okresie oraz rekordową frekwencję w Tatrzańskim Parku Narodowym, zwłaszcza w okolicy 15 sierpnia na szlaku wiodącym do Morskiego Oka i Doliny Pięciu Stawów Polskich.

SŁOWA KLUCZOWE: park narodowy, ruch turystyczny, Tatrzański Park Narodowy

Ewa LISOWSKA-MIESZKOWSKA

KONWENCJA W SPRAWIE TRANSGRANICZNEGO ZANIECZYSZCZANIA POWIETRZA – 40 LAT DZIAŁAŃ NA RZECZ POPRAWY JAKOŚCI POWIETRZA

STRESZCZENIE: W 2019 r. minęło 40 lat od momentu podpisania w Genewie Konwencji w sprawie transgranicznego zanieczyszczania powietrza na dalekie odległości, której podstawowym celem jest ochrona środowiska i człowieka przed skutkami zanieczyszczenia powietrza. W ciągu tych lat do tekstu konwencji przyjęto 8 protokołów dotyczących kontroli emisji podstawowych zanieczyszczeń powietrza. Dzięki działaniom prowadzonym w ramach konwencji udało się rozwinąć współpracę międzynarodową, która przyczyniła się do zmniejszenia zanieczyszczenia powietrza tlenkami siarki i azotu, a także ograniczenia emisji innych zanieczyszczeń. Rozwinięto program badawczy EMEP, modelowanie i prognozowanie stanu powietrza i przepływów zanieczyszczeń, zgromadzono ogromne ilości informacji w bazach danych. Nadal jednak pozostaje dużo do zrobienia a zanieczyszczenie powietrza jest w poważnym problemem w regionie EKG ONZ.

SŁOWA KLUCZOWE: zanieczyszczenie powietrza, jakość powietrza, prawo międzynarodowe, porozumienie międzynarodowe, konwencja regionalna

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