



KONFERENCIAKÖTET

Conference Proceedings

**Nemzetközi tudományos konferencia
a Magyar Tudomány Ünnepe alkalmából**
International Scientific Conference
on the Occasion of the Hungarian Science Festival

Sopron, 2022. november 3.
3 November 2022, Sopron

**TÁRSADALOM – GAZDASÁG – TERMÉSZET:
SZINERGIÁK A FENNTARTHATÓ FEJLŐDÉSBEN**

SOCIETY – ECONOMY – NATURE: SYNERGIES IN SUSTAINABLE DEVELOPMENT

Szerkesztők / Editors:

OBÁDOVICS Csilla, RESPERGER Richárd, SZÉLES Zsuzsanna, TÓTH Balázs István

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TARTALOMJEGYZÉK / CONTENTS

1. szekció (személyes): Fenntartható gazdálkodás és menedzsment, körforgásos gazdaság Session 1 (personal): Sustainable Economy and Management, Circular Economy

Az ökológiai termelés és termékek piacának változásai a COVID-19 okozta megszorítások alatt

Dr. GYARMATI Gábor11

Fenntartható fejlődés és körforgásos gazdaság a vállalkozások mindennapi életében

Dr. FEKETE-BERZSENYI Hajnalka – Dr. KOZMA Dorottya Edina –

Dr. MOLNÁRNÉ dr. BARNA Katalin – Prof. Dr. MOLNÁR Tamás26

Fenntarthatóság a divatiparban (?) – Négy divatipari szervezet CSR jelentésének rövid áttekintése, valamint a fenntarthatóságra törekvés fogyasztók általi észlelésének vizsgálata

VIZI Noémi39

Épített örökségeink fenntarthatósága a volt szovjet laktanyák újrahasznosításának példáján keresztül

TEVELY Titanilla Virág52

2a. szekció (személyes): A fenntartható fejlődés globális és regionális vetületei

Session 2a (personal): Global and Regional Aspects of Sustainable Development

A migráció mérésének módszertani nehézségei

RUFF Tamás65

2b. szekció (személyes): A fenntartható fejlődés globális és regionális vetületei

Session 2b (personal): Global and Regional Aspects of Sustainable Development

Munkaérték preferenciák vizsgálata a szállítási ágazatban

Dr. BALÁZS László – Dr. KŐKUTI Tamás73

3. szekció (személyes): Turizmus és marketing, fenntartható turizmus

Session 3 (personal): Tourism and Marketing, Sustainable Tourism

Studentifikáció Lágymányoson, avagy az újbudai egyetemek hatása a fenntartható turizmusra

KISS Bence Álmos – PORHAJAS Gábor László85

Book Consumption Literature – Literature Review on the Subject of the Behavior of Book Consumers

Miklós LÉGRÁDI – Dr. habil. Zoltán SZABÓ96

Szállodaüzemi intézkedések irányvonalai a fenntarthatóság jegyében

MARTOS János András114

**Sportfogyasztási szempontú elemzés a Sopronban rendezett
2021-es Női Vízilabda Magyar Kupáról**

CSISZÁR Szabolcs János – Dr. habil. PAÁR Dávid126

4a. szekció (személyes): Pénzügyek, számvitel, fenntartható pénzügyek

Session 4a (personal): Finance, Accounting, Sustainable Finance

**A könyvviteli szolgáltatási szakma megítélése. Összehasonlító elemzés
a 2020. és 2022. évek felmérése alapján**

Dr. VERESS Attila – Dr. SIKLÓSI Ágnes – Dr. SISA Krisztina A.136

A KKV-szektor hitelezési tendenciának értékelése MNB adatok alapján

MÁRKUS Mónika147

**Az ellátási láncok fenntartható pénzügyi adaptációja
– rövidtávú fizetési kötelezettségek finanszírozása**

Dr. CZIRÁKI Gábor – HACKL János158

**ESG közzététel vizsgálata nemzetközi háttérű kereskedelmi bankok esetében
Magyarországon**

SIKLÓSI Veronika172

4b. szekció (személyes): Pénzügyek, számvitel, fenntartható pénzügyek

Session 4b (personal): Finance, Accounting, Sustainable Finance

A fenntarthatóság és az osztalékpolitika kapcsolata

Dr. KUCSÉBER László Zoltán – Dr. CSOMA Róbert180

**Pénzügyi és öngondoskodási ismeretek a magyar középiskolák
végzős osztályaiban 2021-ben**

KOVÁCS Zoltán – TÖRÖNÉ Prof. Dr. DUNAY Anna 188

A cégértékelés módszertani kihívásai

FÁBIÁNNÉ JÁTEKOS Judit Ilona203

5. szekció (személyes): Sustainable Economy, Management and Development

Session 5 (personal): Sustainable Economy, Management and Development
(session in English)

The Qualitative Characteristics of Accounting Information: A Literature Review

Asma MECHTA – Prof. Dr. Zsuzsanna SZÉLES – Dr. Ágnes SIKLÓSI219

**Tourism Development in Indonesia - Surakarta City Role Supporting
National Tourism Planning**

Dr. Rizky Arif NUGROHO – Laura BAZSÓNÉ BERTALAN PhD –

Judit PAPPNÉ VANCsÓ PhD228

**Green Manufacturing Practices Towards Sustainable Development
in the Ready-Made Garments (RMG) Industry of Bangladesh**

Dr. Md. Sadrul Islam SARKER – K. M. Faridul HASAN – Dr. István BARTÓK241

Drivers and Barriers of GSCM Practices Implementation: Literature Review <i>Khouloud CHALLOUF – Dr. Nikoletta NÉMETH</i>	252
--	-----

6. szekció (személyes): Tourism and Marketing, Sustainable Tourism
Session 6 (personal): Tourism and Marketing, Sustainable Tourism
(session in English)

Impact of COVID-19 Pandemic on Tourism Sector in Vietnam <i>Thi Thuy Sinh TRAN – Dr. Nikoletta NÉMETH – Dr. Thai Thuy PHAM – Nhat Anh NGUYEN</i>	259
--	-----

Tourism in Troubled Times: the Economic and Social Effects of Short- and Expected Long-Term Changes <i>Dr. habil. Tamás SZEMPLÉR</i>	276
--	-----

Application Areas of Drones: Exploratory Research from Residential and Corporate Perspectives <i>Bendegúz Richárd NYIKOS – Astrid IONESCU</i>	286
---	-----

7. szekció (online): A fenntartható fejlődés globális és regionális vetületei
Session 7 (online): Global and Regional Aspects of Sustainable Development

Németország elektromos személygépjármű exportja az Európai Unió tagállamaival <i>Dr. KONKA Boglárka</i>	295
---	-----

Fenntartható design - új megközelítések a terméktervezésben <i>NÁDAS Gergely – Dr. habil. MOLNÁR László</i>	307
---	-----

Challenges of the Adaptation Planning – Evolution of the Vulnerability Assessment Methodologies <i>Pál SELMECZI</i>	322
---	-----

Szisztematikus irodalmi áttekintés a személygépjárművekbe épülő elektromos hajtáslánc gyártásáról a fenntarthatóság szempontjából <i>Dr. TÓTH Árpád – BEGE András</i>	329
---	-----

Németország az európai labdarúgás térképén – jogi és sportföldrajzi megközelítés <i>Dr. ENGELBERTH István – Dr. VIRÁGH Árpád</i>	344
--	-----

A körforgásosság mérési lehetőségeinek vizsgálata a szállodaüzemeltetésben <i>KARAKASNÉ Dr. MORVAY Klára</i>	360
--	-----

Az állami nyugdíjrendszerek fenntarthatóságának kihívásai <i>SZABÓ Zsolt Mihály</i>	377
---	-----

Competencies for Sustainable Development <i>Zsuzsanna NAGYNÉ HALÁSZ</i>	391
---	-----

8. szekció (online): Turizmus és marketing, fenntartható turizmus
 Session 8 (online): Tourism and Marketing, Sustainable Tourism

Gyógynövényturizmus és az abban rejlő lehetőségek – Az Észak-Magyarországi kínálati oldal primer vizsgálata <i>PÁSZK Norbert</i>	400
---	-----

Fiatal külföldi turisták pozitív és negatív tapasztalatai Budapesten <i>Dr. habil. GROTHE Judit – MAGYAR Tímea</i>	408
--	-----

Mit ígér Bükkfűrdő? A városmárka-kommunikáció lehetséges eszközei és csoportosításuk a POE-modell alapján <i>HORVÁTH Kornélia Zsanett</i>	417
---	-----

9. szekció (online): Fenntartható gazdálkodás, körforgásos gazdaság
 Session 9 (online): Sustainable Economy, Circular Economy

Erdei biomassa lehetőségei és korlátai Magyarország energiabiztonságában <i>VARGOVICS Máté – Dr. NAGY Dániel</i>	433
--	-----

A körforgásos gazdaság és a soproni hulladékfeldolgozó stratégiája <i>KASZA Lajos – Dr. NÉMETH Patrícia</i>	444
---	-----

10. szekció (online): Sustainable Economy, Management and Development
 Session 10 (online): Sustainable Economy, Management and Development
 (session in English)

Comparison of the Density of Physicians and General Practitioners in the Hungarian Csongrád-Csanád Country and in the Territorial Units of Vojvodina for the Period 2002-2020 <i>Dr. Ivana KOCSICSKA</i>	453
--	-----

The Re-Consideration of Business Diplomacy and Corporate Social Responsibility for International Business in the Post-Covid-19 World <i>Anh Tuan TRAN</i>	463
---	-----

Examining the Process of Project Preparation <i>Attila LEGOZA</i>	474
---	-----

The Relativity between Sustainable Management and Turnaround Management: Evidences and Suggestions for the Hungarian Agricultural Sector <i>Zsuzsanna VARGA – Dr. habil. Etelka KATITS – Dr. Éva SZALKA – Dr. Ildikó PALÁNYI – Katinka MAGYARI</i>	484
--	-----

Developing countries and Sustainability <i>Arjana KADIU – Dr. habil. Zoltán SZABÓ</i>	504
---	-----

The Effect of Supply Chain Management in Achieving Sustainability in Supply Chain in Four Seasons Hotel in Syria <i>Wael ALASFAR</i>	519
--	-----

**The Role of EGTCs and Euroregions in Economic Cooperation Across
the Hungarian-Romanian Border Between the Period 2007-2020**

Melinda BENCZI 531

11. szekció (online): Poszter szekció

Session 11 (online): Poster Session

Procrastination and its Influencet on Retirement Saving Plann

Khaliunaa DASHDONDOG540

Színházi kommunikáció 2.0

Hazai közsínházak jelenléte Facebookon és Instagramon a pandémia első évében

Dr. DÉR Cs. Dezső – Dr. habil. PAPP-VÁRY Árpád Ferenc – ZRINYI Ivett554

A felnőttképzésben résztvevő álláskeresők elhelyezkedési esélyei

Szabolcs-Szatmár-Bereg megyében

LE-DAI Barbara575

Cost Analysis of Sustainable Concrete Production Using Waste Nanoparticles

Omar ZINAD – Dr. habil. Csilla CSIHA – Prof. Dr. Alya'a Abas AL-ATTAR585

Challenges of the Adaptation Planning – Evolution of the Vulnerability Assessment Methodologies

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Abstract

The climate change is one of the greatest global challenges of our time. In the past, climate policy focused primarily on preventing and reducing greenhouse gas emission: that is mitigation policy. In the last decade, the adaptation to the impacts of climate change has become critical due to the accelerating weather extremities. There is significant difference between mitigation and adaptation policies. The later focuses on local impacts and responses, while the mitigation sets global goals for reduction of greenhouse gas emission. In 2007, the IPCC 4th Assessment Report defined the concept and methodological framework for vulnerability assessment, and in the last decade many countries and regions developed their adaptation strategies based on this framework. In 2014, the IPCC 5th Assessment Report, and after the IPCC 6th Assessment Report modified the vulnerability assessment framework. In this study, I examine the latest approaches of climate change vulnerability assessment methods and how this methodology has evolved in the last decades.

Keywords: climate change, climate adaptation, adaptation policy, vulnerability assessment

JEL Codes: Q54, Q58, R58

1. Objective of the research topic

In this study I would like to examine the latest approaches and practices of regional and sectoral climate change vulnerability assessment. As part of the research, I will evaluate adaptation policies and possible interventions, and introduce the importance of local adaptation against global mitigation efforts. In this review I focused on the evolution of the vulnerability assessment methods. To achieve this goal I concentrate on the following main research questions:

- What are the newest methods of climate change vulnerability assessment?
- How they developed through the IPCC 4th, 5th and 6th Assessment Reports? Through these I try to identify both the evolution of the methodology and the methodological problems and gaps.

2. Development of vulnerability methodologies

FitzGibbon and O. Mensah (2012) have made a comparative analysis of Ritter and Weber's (1973) characteristics of wicked problems and the extent of their manifestation in climate change vis-à-vis water management in Ghana. Based on this, it can be concluded that climate change is a wicked problem. Therefore, climate change adaptation planning needs a tool to help avoid maladaptation and find right solutions of adaptation. Vulnerability assessments are the main tool for this through this solution.

To secure (or at least facilitate) sustainable development of given territories, considering both the aspects of environmental, social and economic factors of sustainability, is a complex development policy challenge. It is even more complex when the territory is affected by the impacts of the climate change, which issue, as we saw earlier, can be classified as a wicked problem. To find proper responses for these challenges, it is inevitable to study the local environmental and climatic circumstances and the potential social/economic answers. Vulnerability assessments make us capable of finding these answers, hopefully the proper ones.

The development of vulnerability assessment methodologies can be observed in several areas (food security, disaster management, climate change adaptation). Methods of these analysis are mostly based on the observation that external change in a system usually does not affect different actors of the system equally or uniformly (different regions, sectors, and social groups are affected differently). These differences are caused by factors introduced below.

The change in the state of the environment and the direct factors of the changes (*exposure*) will be different in each area. For example, the amount and distribution of precipitation can change in different ways, even within a smaller country, like in Hungary.

Another cause of the differences is that individual regions, sectors, or social groups (“affected system”) can withstand the changes to varying degrees. This is measured by *sensitivity*, the weather dependent behaviour of the affected system. It is easy to see, for example, that the effects of heatwaves can have severe consequences for older age groups but at the same time they mean a significantly lower risk for the younger ones (Páldy & Bobvos, 2008). In some valley or foothill located areas, the increased precipitation may result in a significant municipal rainwater inundation and thus a loss of yield, depending on the geological and soil conditions. In contrast, in other areas, the yield of agricultural production may even improve because of more precipitation.

The third factor that can have a decisive impact on the vulnerability of a given area is the quality and strength of the social/economic responses to change and the ability of a given site to cope with the adverse effects of climate change (*adaptive capacity*). In this respect, the level of socio-economic development of each region and their regional differences can be crucial. For example, unfavorable income and/or infrastructure conditions may hinder the stakeholders of an underdeveloped area to take effective adaptive measures of adaptation to the effects of climate change (Rotárné et al., 2016).

Adequate knowledge about these three factors (exposure, sensitivity, adaptive capacity) and detailed exploration, evaluation, and understanding of the relationship between them provides an opportunity to determine the vulnerability of regions to climate change. At the same time, it is essential to mention that in this respect, differences in the methodologies of vulnerability assessments can be observed between the different research communities and schools.

3. Development in the conceptual approach and assessment methodologies for vulnerability since the 1980s

The concept of vulnerability has been widely used since the 1980's to study environmental issues such as disaster risks, global environmental impacts, or impacts of climate change. These issues influence the sustainable development exceptionally, so their use can help to move environment and climate change policies in a sustainable direction. At the same time, the concept has been applied in the social sciences, too. In their work on the evolution of vulnerability studies, Füssel and Klein (2006) identify three fundamentally different approaches in this area:

- The **risk- and hazard-based approach** is most prevalent in the technical sciences' risk assessments and disaster analyses. In this approach, vulnerability means the threat that an external source poses to the investigated system. It basically examines the relationship

between the magnitude of the impact and the responsiveness of the affected system. This approach focuses on the sensitivity parameter of the aforementioned IPCC methodology.

- The **social science approach** examines social vulnerability, focusing on the household and the community, which are fundamentally influenced by socio-economic and political factors. In this approach similarities with the IPCC methodology's adaptation capacity pillar can be observed.
- According to the **integrated approach** developed by the IPCC, vulnerability "*refers to the degree of vulnerability, and to the lack of adaptation to adverse climatic effects. It depends on the nature and extent of climate change affecting the system and the sensitivity and adaptability of the system*" (IPCC, 2007). This approach is emphasized further in the IPCC 5th Assessment Report, which claim that the risks of climate change stem from the interactions of climate-related threats (including hazardous events and trends) with vulnerable anthropogenic and natural systems, taking into account the latter's ability to adapt (IPCC, 2014). The IPCC 6th Assessment Report uses also the framework of the 5th Assessment Report (IPCC, 2022).

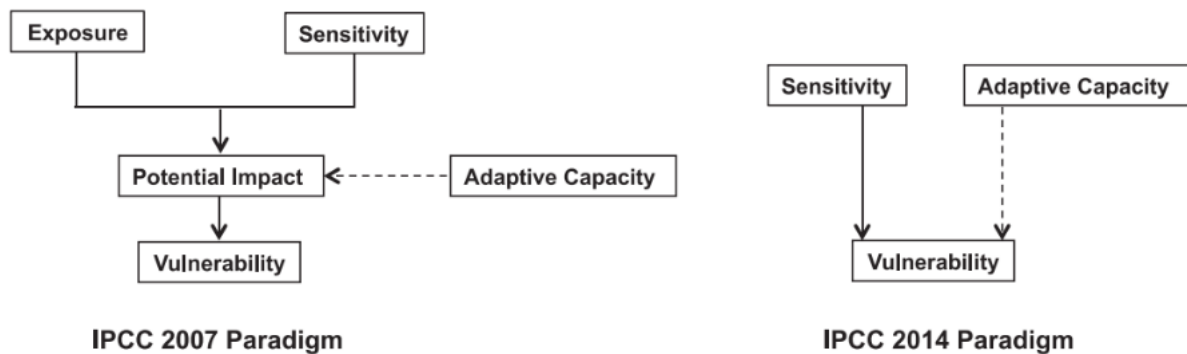


Figure 1: The concept of vulnerability is presented in the IPCC 4th and 5th Assessment Reports

Source: Sharma et al. (2019)

The new assessment framework introduced in the IPCC 5th Assessment Report focuses on risks, as opposed to the previous methodology, which puts vulnerabilities at the center (IPCC, 2014; IPCC, 2022). A further difference is that while previous assessments have taken into account exposure (namely the direct effects of climate change) in determining vulnerability, the newer methodology only takes this into account at the level of risk.

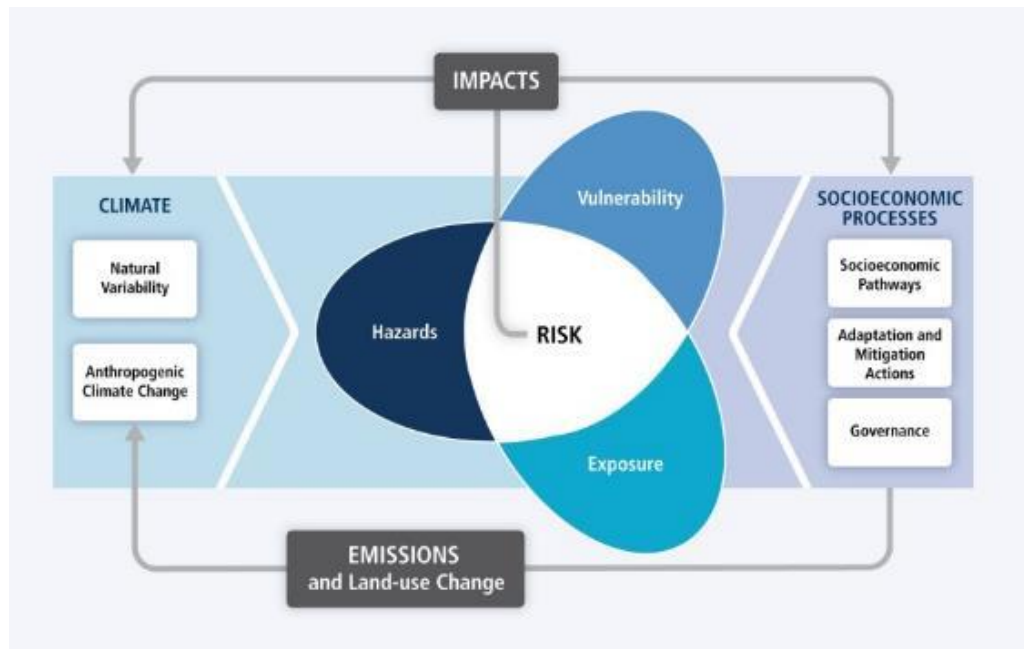


Figure 2: Illustration of the core concepts of the IPCC 5th Assessment Report
Source: IPCC (2014)

However, this approach is problematic in several aspects. The primary question for the evaluators and planners is: to what the settlements or areas are vulnerable. However, omitting the exposure does not provide an answer to this question in the vulnerability study. The methodology only takes sensitivity and adaptability into account: Vulnerability in IPCC 6th Assessment Report „is defined as the propensity or predisposition to be adversely affected and encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (IPCC, 2022)

Another problem is that risk is in the center the concept, but by definition it does not take into account the damage, only the probability of the occurring effects. Risk is defined in the IPCC 6th Assessment Report „as the potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems” (IPCC, 2022). However, the common definition of risk states that risk is the result of probability and damages (Kerekes, 1998). Due to methodological inconsistencies and difficulties of the newer methodologies it is used in assessments and planning, the vulnerability assessment framework introduced in the IPCC 4th Assessment Report is still used (Sharma, 2019) in practice (e.g. COPENICUS, NAGiS).

The vulnerability assessment concept has undergone significant development since its first appearance. Moreover, this development is still ongoing today. Methodologies based on the IPCC 4th Assessment Report methodology are currently the most widely used in climate vulnerability studies.

The structure of climate vulnerability assessments is not entirely uniform, and even there are special analytical pathways (strategies) for assessing impacts and adaptation options that cannot be integrated into the basic structure of vulnerability analyses. The most important types of analysis developed during the evolution process of climate vulnerability assessments are as follows (Füssel & Klein, 2006):

- **Impact assessments** model the direct impact of one or more climate scenarios according to impact mechanisms without considering the possible adaptation of the studied objects. They typically consist of only a quantitative component and are often entirely neglect non-climatic factors. This analysis path is most common for smaller modeling studies within a single sector.

- **Vulnerability assessments (*sensu stricto*):** in addition to taking stock of the expected effects, these analyses also consider the adaptability of the objects and, through this, seek to assess the vulnerability. It is currently the most widely used analytical strategy of the comprehensive, interdisciplinary studies of climate change consequences.
- **Adaptation assessments:** While the primary purpose of impact assessments and vulnerability assessments is to make the most realistic estimation of climate risks associated with each site and object, adaptation analyses aim to optimize possible adaptation (and sometimes mitigation) strategies. To this end, interdisciplinarity, broad stakeholder involvement, and a multi-circular, iterative analysis are its most essential aspects.

Some authors consider only the second type in the list, specifically focusing on vulnerability assessment, to be a real "vulnerability" analysis. Meanwhile, others use the term in a broader sense to include several related techniques for assessing effects, sensitivity, vulnerability, and adaptability.

In Hungarian practice and climate policy, the second approach is widely used. The National Adaptation Geoinformational System (NAGiS) and the National Adaptation Strategy are also based on this. They follow the CIVAS model, which is based on the definition published in IPCC AR4 (Selmeczi et al., 2016). Accordingly, the territorial effects of climate change are examined in the context of exposure → sensitivity → expected impact → adaptive capacity → vulnerability (Pálvölgyi & Czira 2011)

The biggest challenge in vulnerability assessments is the evaluation of adaptability. Pappné Vancsó and her co-authors in 2016 examined the methods of estimating adaptability. They found that most adaptability studies use widely available big databases to determine adaptability. However, this data does not take into account adaptation practices. They came to the conclusion that the most important element of the adaptation complex indicators should be data and information on adaptation practices, and for this, questionnaires and fieldwork are essential (Pappné Vancsó et al. 2016).

In the longer term, the evolution of vulnerability assessments clearly points to the direction of adaptation analyses, directly addressing the relevance of most critical policy issues (UNDP, 2003) and recognizing the importance and complexity of the interactions between biophysical and socio-economic systems. In addition to and instead of linear, single-sector-focused climate impact assessments, complex multisectoral or integrated analyses are gaining ground and role. I also consider this direction to be followed for analyses to be developed within the framework of local and regional climate strategies. The report of the second working group of the IPCC 4th Assessment Report also underlines the importance of cross-sectoral and integrated analyses and identifies their development as a priority in climate policy assessment activities (Carter et al., 2007; Fischlin et al., 2007). However, even the most complex and integrated models are relatively more straightforward sub-models focusing on specific issues, and the development of models on topics is also one of the research priorities recommended by the IPCC (Carter et al., 2007). Integrated assessment models can also increase the effectiveness of responses by facilitating and applying relevant tools, designing appropriate governance structures, and adequate institutional and human capacities. Integrated answers are particularly relevant in energy infrastructure planning and implementation for interactions between environmental elements/systems and infrastructure or urban planning (IPCC, 2014).

4. Conclusions

The adaptation is a constantly developing field of research during the recent decades. Its importance has been significantly growing in the international climate policy, especially since the Paris Agreement, when it was declared as an equal counterpart of mitigation. Adaptation to unavoidable impacts is very important for states, as impacts occur locally and regionally. In

Hungary where GHG emissions are not significant, but impacts of climate change are present and will be present for centuries, adaptation will be more important task of climate policy than mitigation. Vulnerability assessments are essential for the development of adaptation strategies and measures and find sustainable solutions in regional development policies. Evolution of these vulnerability assessment methodologies show a perpetual development. Currently the most frequently applied approaches as follows:

- Impact assessments model: the direct impact of one or more climate scenarios according to impact mechanisms without considering the possible adaptation of the studied objects.
- Vulnerability assessments: in addition to taking stock of the expected effects, these analyses also take into account the adaptability of the objects and, through this, seek to assess the vulnerability.
- Adaptation assessments: While the primary purpose of impact assessments and vulnerability assessments is to make the most realistic estimation of climate risks associated with each site and object, adaptation analyses aim to optimize possible adaptation strategies.

In IPCC 4th Assessment Report, the standard vulnerability assessment methodology was used, but the IPCC 5th Assessment Report has moved towards a methodology for adaptation assessments. This methodology puts risk at the center. According to this, the risk is determined by exposure, vulnerability and hazard, however, the damage cannot be properly identified in this approach, so the risk cannot be determined. The practical evaluations in recent years continue to use the IPCC 4th Assessment Report methodology. This is true even for Hungary, where the NAGiS system as the leading climate policy decision supporting and vulnerability assessment tool of the country, uses IPCC 4th Assessment Report definition as its methodological basis.

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