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Coastal zone, key area for adaptation to sea level rise. The Gulf of Gdansk case

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Abstract: Climate change and its consequences, including rising ocean temperature and sea level rise are well scientifically documented. The changes are especially severe for coastal communities, which are estimated to have reached c. 50% of the world's population. Using an example of the Gulf of Gdansk region, which is of European importance, due to the presence of two major Baltic ports and global tourism, we explore, how sea related threats may affect the region and we analyse how the three major cities are prepared to these threats. The four city developmental strategies and an additional document, an "umbrella strategy" focusing on climate change threats do not consider sea level rise and more frequent storm surges as threats. The sea level rise is briefly discussed in the fourth document. The adaptation plan, an appendix to the document, mentions sea level rise, but the discussion of the problem is indirect and involves some examples of adaptation actions in loosely similar environmental conditions. The adaptation plan, in fact includes a list of possible threats, rather than a detailed discussion of the suggestions of the measures to be undertaken. For comparison, we present a multilevel approach, which is effectively run in the Port of Rotterdam and argue that such approach should be undertaken in the studied region. We conclude that despite years of education on climate change, the problem is still not recognised and is underrepresented in practical measures of the studied region. We also provide hints on how to overcome this situation.

Keywords: adaptation to climate change, coastal zone, developmental strategy, Gulf of Gdansk, sea level rise

INTRODUCTION

Climate change is a fact and it causes serious consequences for all parts of the world. Many of these consequences are getting increasingly more severe both worldwide and locally (IPCC, 2019; UNEP, 2019b). We know now that the air temperature has been constantly raising and in accordance with the International Panel on Climate Change (IPCC) these changing conditions have severe impacts in all areas of our lives through impacting both social and environmental systems and causing significant economic losses (IPCC, 2018; IPCC, 2019; UNEP, 2019b). Human settlements are vulnerable areas, since the adverse effects of the changes are magnified through, e.g. urban heat spots, sea level rise, extreme rains causing flooding and wildfires (Hallegate *et al.*, 2013; Zielinski *et al.*, 2016; Heikkinen *et al.*, 2020). Clearly, humanity needs to understand that adaptation to climate change is not an option anymore, it is a real and urgent need (IPCC, 2014; IPCC, 2019; Donatti *et al.*, 2020).

The sea level rise has become one of the key climate change indicators (UNEP, 2019b). The reports estimate that by 2100 sea level rise may reach even 2 m, which would have catastrophic consequences for all coastal communities and beyond, with destruction of existing infrastructures, resulting in human migrations to other regions (Kulp and Strauss, 2019).

The UN estimates that over 50% of the world's population lives in coastal regions (defined as an area within 60 km of the coast) and close to 50% of big cities (with populations over 1 mln) are located in these areas (UN Atlas of the Oceans, no date). A rise in sea level endangers coastal infrastructures around the world, including ports, shipyards and recreational facilities, which are crucial not only for local job markets and industries but also for the widely understood human well-being. Understanding how a sea level rise may impact coastal areas and their populations is critical for coastal planning and the assessment of potential benefits and costs of climate mitigation, as well as the costs of

disasters due to the lack of proper preventive actions (Nauels *et al*., 2017; Kulp and Strauss, 2019).

Well prepared coastal urban areas (e.g. coasts of the Netherlands or Singapore), which are usually economically strong and enjoy steady economic growth, become centers for climate change mitigation and adaptation activities and hence are the frontrunners and leaders for these actions (Hallegatte *et al*., 2013).

Coastal communities and their local, central as well as global authorities should notice the problem and take appropriate actions in order to mitigate the changes and to adapt to the new reality (Dumała *et al*., 2021). The scale of the problem is vast and thus it requires the involvement of all stakeholders on a local, national, regional and international levels (Dupuis and Biesbroek, 2013; Busch, Bendlin and Fenton, 2018; Donatti *et al*., 2020; Kotyńska-Zielińska *et al*., 2020). Citizens must take responsibility for the actions on various levels from e.g. individual changes in daily actions to joint large-scale initiatives including private sector and other communities (Woodruff and Stults, 2016; Heikkinen *et al*., 2020).

A city of Rotterdam works as a good example for such complex approaches, which currently include such structures as: dams, seawalls, storm surge barriers, dikes, dunes, pumps, sluices and regular beach nourishments. All these systems are guilt and managed by the national government, provincial and municipal authorities.

The Gulf of Gdansk region presents all the opportunities for multilateral development, through ports and shipyards, cargo shipping, being highly desirable touristic destination and in consequence, being an area of high population, which due to tourism, triples in summer. This region is also of multilateral importance, from local, as a place for over 1 mln people to live and work, to regional and global, thorough its touristic importance and, like in the case of Rotterdam, the key role of ports in Gdynia and Gdansk in the global shipping system.

In this paper we describe the climate change related sea level rise and its coastal consequences. Then, we assess the preparedness of the three major cities (Gdansk, Sopot, and Gdynia) to the ongoing climate changes. This is being achieved through extensive analyses of the actions described in their strategic plans. We demonstrate, how sea related threats may affect the region and how these problems are underrepresented in the selected strategies.

According to the IPCC mitigation of climate changes, relates to "human intervention to reduce the sources or enhance the sinks of greenhouse gases", while adaptation to the changes involves actions to adjustment to the observed or predicted climate changes and their impacts, thus actions aiming at minimising the adverse effects of the changes (IPCC, 2014; IPCC, 2019).

The two approaches are different and they produce different outcomes but both are necessary to efficiently challenge the adverse changes. Mitigation relates to more global problems and can be mostly tackled on a trans-regional or even global levels, while the adaptation is more related to smaller scale actions, at local or regional levels. If mitigation actions were successfully run, their outcomes will be observed after decades and that's why humans must take actions to adapt to the changes in order to secure their future well-being.

For mitigation actions, the United Nations Environment Programme Report defined eight indicators, which focus on activities related to climate change (UNEP, 2019a). These include the following actions:

1) minimising the scale and impact of climate change;
2) minimising environmental threats;
3) supporting human well-being through healthy ecosystems;
4) strengthening governance in an interconnected world;
5) ensuring sound management of chemicals and waste;
6) accelerating the transition to sustainable societies;
7) promoting evidence-based decision-making;
8) providing knowledge to policymakers.

While in the area of adaptation, the UN promotes projects that utilise biodiversity and ecosystem services as part of a holistic adaptation strategy (ecosystem-based adaptation). Spreading vital adaptation knowledge through well-connected global networks and providing interface between adaptation research community and decision-makers are additional actions, which are complemented by the support countries to advance their National Adaptation Plans (UNEP, 2020).

Rising sea level is one of the inevitable effects of climate changes in every part of the world. Average ocean level has increased by over 23 cm since 1880 and the predicted (due to carbon emissions) global rise amounts to c. 30 cm by 2050 (IPCC, 2019).

Local sea level rise and storminess vary significantly between regions. Based on long-term satellite data, wave height shows an overall global increase (Young and Ribal, 2019), but large regional differences are reported, from large changes in the Southern Ocean to negligible effects in the North Sea. Such spatial variations are likely to result in regional variations in erosion and sedimentation (Brown and Nicholls, 2015).

Sandy beaches worldwide have been retreating at a level between 8 and 3% annually between 1984 and 2016 (Besset, Anthony and Bouchette, 2019). These authors reported that in case of 54 studied river deltas around the world, 29 deltas are in retreat, 18 shorelines are advancing and 7 have not shown any change over 30 years. Luijendijk *et al*. (2018), using Landsat images, confirmed that 24% of the world sandy beaches were retreating at a rate faster than 0.5 m annually, while 28% were advancing and 48% didn't show any change between 1984 and 2016.

Such changes result in an increasing tendency to damage from erosion in many regions, which not only impacts organisms that use the coasts for nesting or nurseries, or reduction of bioproductivity of the coastal area but also coastal socioeconomic activities and properties, including tourism (Stronkhorst *et al*., 2018).

Major socioeconomic impacts will occur at locations where land loss coincides with high population density. For many world regions, the management of coastal erosion threats involves costly, long-term engineering interventions. Many coastal urban areas have over 50% of their coasts reinforced by engineering structures (Chee *et al*., 2017), which however, are not adequate to protect against projected future sea level rise and storm surges. Therefore, these structures must be adapted to resume their role in protecting cities from the sea (Lincke and Hinkel, 2018).

Practices for coastal erosion management are progressively changing from only responsive to external impacts to coastal resilience ideas, which apply adaptive management and view the coastal area from a holistic, long-term perspective (Wright and Wu, 2019; Pikner *et al*., 2022).

Recent developments in coastal protection have involved addition of "greener and softer" forms of coastal stabilisation versus structural engineering. These forms (nature-based solutions) increase ecological co-benefits but also use resilient attributes of natural systems, such as adaptive potential of e.g. beach, dunes, coastal vegetation (Reguero *et al.*, 2018).

Sea level rise adaptation strategies must define risks, develop and implement modern management approaches to secure the reduction of the risks to citizens, communities and ecological systems in the coastal zone. However, upgrade of coastal infrastructure is highly related to economic factors and in case of port systems, which are highly susceptible to sea level rise, changes are necessary in port installations and their management, including dredging.

Many coastal cities (like e.g. Rotterdam, Singapore or Shanghai) are planning adaptations, including rising walls and changing and/or modifying urban development plans and strategies (e.g. Port of Rotterdam (no date a)). So, how does it look in the region of the Gulf of Gdansk?

MATERIALS AND METHODS

The Gulf of Gdansk (including the Vistula Lagoon) is a unique area, whose both environmental and social (economic) features (Tab. 1) facilitate a great case study for the perception and preparedness actions for the adaptation of the region to climate change (sea level rise) related threats. The area map is shown in Figure 1.

The area of the Gulf of Gdansk basin is approx. 6,300 km^2 and the majority of the Gulf coastline is made up of wide and flat sandy beaches, with a number of ports and harbours. The water

Table 1. The Gulf of Gdansk features

Factor	Feature of the Gulf of Gdansk
Environmental factors	Low salinity (5–7 in the shallow waters), shallow waters, with influence from the open Baltic, the Vistula River and smaller rivers, with significant anthropogenic influence. Low depths (around 2 m in the inner Gulf), which facilitate good water sports conditions but also determine environmental challenges. Many valuable habitats (e.g. sea grass meadows, reef fields), protected within various protection instruments (e.g. NATURA 2000). Numerous, touristic natural areas, unique for the region and beyond.
Social and economic factors	Many various stakeholders, with active fisheries communities. Two major Baltic shipping hubs in Gdynia and Gdansk. Highly developed touristic offer. Tourism is a key economy branch for the region. Strong and multiple anthropogenic pressures on marine and coastal areas, which create development-environmental protection problems. Still relatively strong connections to traditions, marine (fisheries) culture, especially in the regions of the Puck Bay and the Hel Peninsula (e.g. traditional fishing, local cuisine). The area covered by a number of managerial initiatives that may facilitate the actual implementation of the ecosystem approach to management (based on the concept of ecosystem services).

Source: own elaboration based on personal information from Jan Marcin Weslawski.

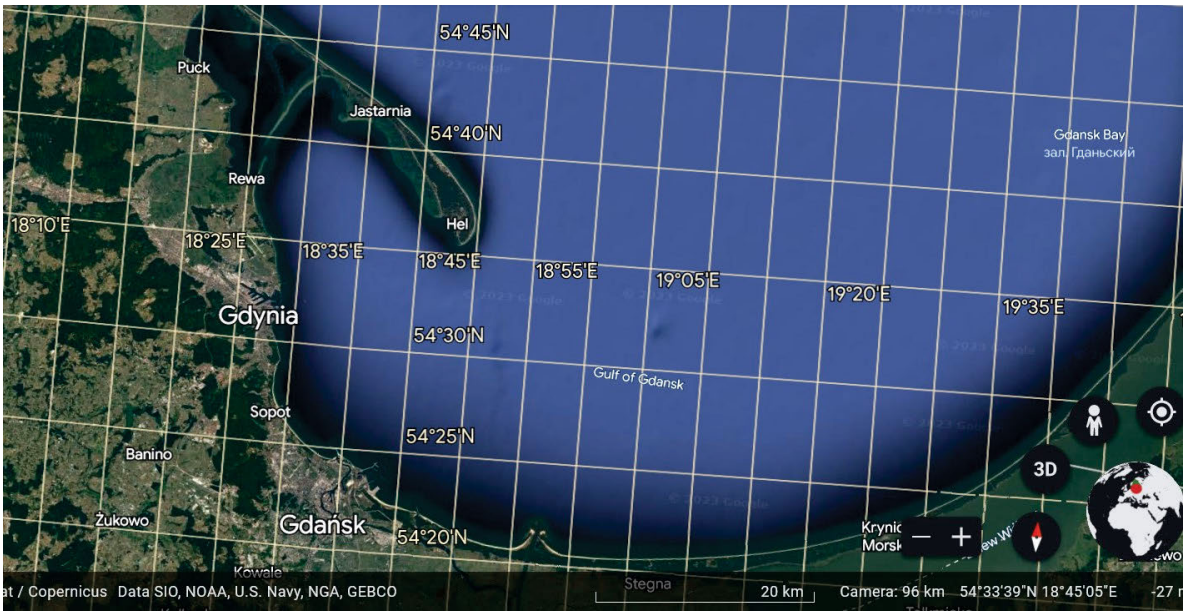

Fig. 1. The Gulf of Gdansk region with Gdynia, Sopot and Gdansk; source: Google Earth

temperature reaches around 21°C in summer, while the basin salinity varies from 5 to 8. The area is populated with over 1 mln people. There are many industrial developments present in the region, including two major Baltic ports of Gdansk and Gdynia, the oil refinery and numerous fish processing facilities. Both ports are of major importance in the global container trade, with Gdansk ranked number 1 and Gdynia number 3 in the Baltic Sea in container handling for 2022 (Port Gdańsk, 2022). The numbers continuously increase and the ports keep developing, so, the future role will be even greater for the global system. The entire region is also a key summer destination with millions of tourists from all over Europe every summer.

Table 1 describes the features of the Gulf of Gdansk and provides the background for the decision of analysing this particular case. The Gulf "offer" is very complex and it is challenging to create a coherent climate change adaptation strategy, which would reconcile the interests of all stakeholders and provide protection for the consequences of the changes.

However, the entire Gulf of Gdansk region, especially Gdansk area, is a subject to major sea level rise consequences, as it can be seen from the projection below (based on the climate change scenario provided by the IPCC) – Figure 2.

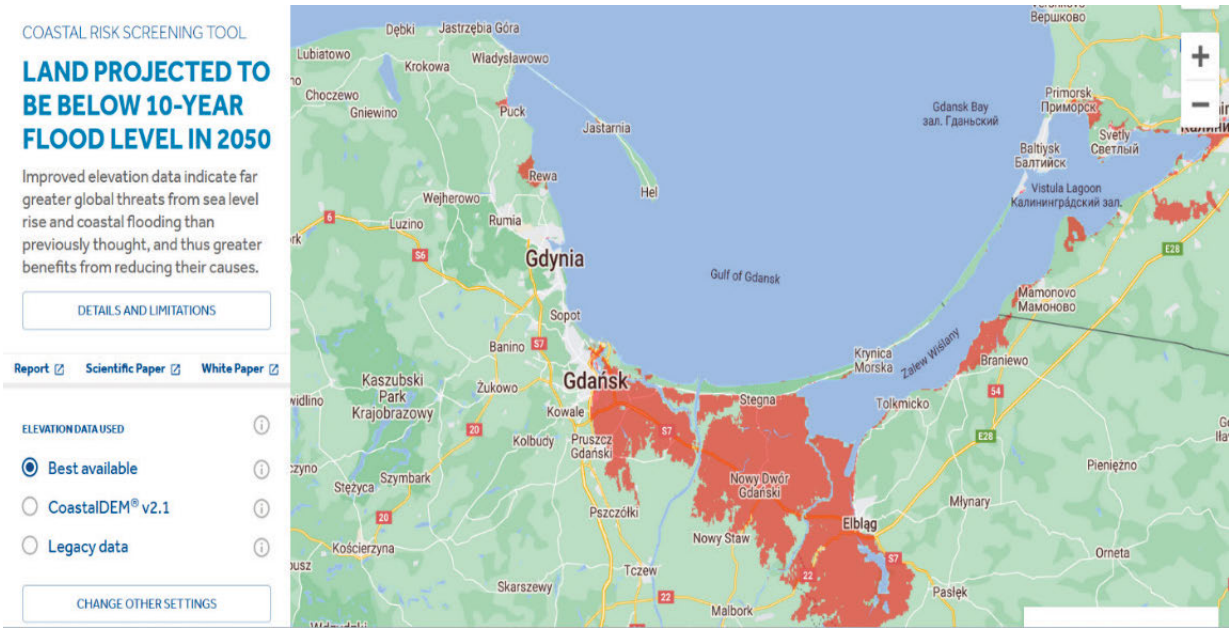

Fig. 2. Land projected to be below 10-year flood level by 2050; source: Climate Central (no date)

Is this problem visible in the regional developmental strategies? In our study of the regional preparedness, we analysed official developmental strategies of the selected towns and cities located in the area of the Gulf (n = 28). These documents were assessed as suitable to evaluate climate change-related issues because they are of long-term character and are likely to include environment-related issues. We applied the content analysis to evaluate these strategies in the context of adaptation plans to climate change related threats, especially sea level rise.

In the initial part of the study the MAXQDA ANALYTICS PRO 2020 was used for text analyses, with two stage approach: the first part included analyses of documents with reference to climate, development and/or environment and with respect to the local, regional and national reference. The climate change codes involved three groups, mitigation, adaptation, and climate change threats. All codes were initially discussed and then collectively defined, and finally used in the MAXQDA ANALYTICS. We applied the content analysis (with criteria established prior to the examination of the documents) using the hermeneutic analysis, which involved interpretation of the document text. Then the documents were analysed and each document analysis was cross-checked. Five documents, prepared for three major cities in the Gulf, were selected and further evaluated. Those were the current developmental strategies of Gdynia, Sopot and Gdansk (commonly known as Tri-city region), namely:

1) Gdynia City Development Strategy (Załącznik, 2017);
2) Gdansk 2030 Plus City Development Strategy (Załącznik, 2014);
3) Sopot Strategy 2014–2020 (Urząd Miasta Sopotu, 2014);
4) Sopot Strategy 2022–2030 (draft) (Załącznik, 2022);
5) the "umbrella document" for the Tri-city, a 245 page long Adaptation and Mitigation to Climate Changes for the Gdansk, Gdynia Sopot Metropoly) (Ekovert, 2021) plus its Appendix.

Since the three current city strategies did not show any direct and indirect references (while using codes) to sea level rise, we performed qualitative analyses of these documents with regard to climate change related risks and sea related threats. In this approach, the analyses focus on a certain subject using non-numeric plus non-quantifiable indicators, and characteristics to determine its overall situation.

RESULTS AND DISCUSSION

The results of the qualitative analyses of the five documents with regard to climate change related risks and sea related threats again showed no direct references were found in any of the three current strategies, namely for Gdynia (39 pages), for Sopot (29 pages) and Gdansk (39 pages). The only statements that somehow relate to climate change, marine environment and sea

are presented in the Table below. Those are not further developed in the city strategies, they serve as information, without any deeper analyses.

Table 2. Text related to climate change or sea in the current strategies of the particular cities

Statement	City strategy (page No.)
Sustainable life style and environmental protection	Gdynia (Załącznik (2017), p. 7)
Clean environment and sea	Gdynia (Załącznik (2017), p. 12)
City benefiting from the sea	Gdynia (Załącznik (2017), p. 18)
We are increasing quality of the environment	Sopot (Załącznik (2014), (p. 7)
Ecological education	Sopot (Załącznik (2014), (p. 9)
Low level of environmental pollution	Sopot (Załącznik (2014), (p. 9)
Pro-environmental transport development	Sopot (Załącznik (2014), (p. 21)
Environmental pressure of planned investments on a low level	Sopot (Załącznik (2014), (p. 29)
Sustainable life style and environmental protection	Gdansk (Załącznik (2014), p. 30)
Lowering greenhouse gas emissions	Gdansk (Załącznik (2014), p. 30)

Source: own elaboration based on city strategies.

Recently, Sopot launched a draft document Sopot Development Strategy for 2022–2030 project 2.0 (Załącznik, 2022), which has not been implemented yet. It does not include direct recognition of the sea level rise.

The qualitative analysis of this document shows that in paragraph 5.1. "Existential challenges", there is a short subparagraph d) entitled "Resilience to crisis", where very briefly challenges related to climate change are mentioned. Mostly the challenges relate to changes in transportation patterns. Then, in the chapter "Goals", there is a very brief note on the aspiration of Sopot to become a zero emission city. The climate neutrality is declared as one of the Strategic Goals (Operational Goal 1.1) and another Operational Goal 1.3 "Ecological Safety", includes a point 1.3.5 "Protection from sea related flooding".

When we further evaluated this document in terms of the proposed implementation plans and their indicators, the sea level rise threats and prevention actions are again not present. The only climate related issues include: CO_2 emission reductions, PM levels, inclusion of greater amount of green energy and rain water retention. The Baltic Sea has suddenly disappeared from the plan. The same absence can be observed within the analysis of the so-called "Obszary strategicznej interwencji" (Eng. Areas of Strategic Intervention) subchapter. The sea related threats are missing in the discussion, even though the areas selected are those in close vicinity to the beach, i.e. areas which will be impacted by the sea level rise (Fig. 2).

The tables and discussion points make the main message blurry and what is even more surprising, Principle C: "Protection of environment, landscape and cultural heritage" is in clear contradiction to the developmental plan of these terrains, which e.g. still allows for many touristic infrastructures to be built in the very vicinity of the sea.

The analysed documents contained little or no information on adaptation measures in response to the potential and/or real threats. There was no mention about sea related threats and the land-sea coexistence was not taken into account in any of the documents.

The additional document that we decided to analyse is the Adaptation and Mitigation to Climate Changes for the OMGGS (Ekovert, 2021). This document is divided into 5 chapters including "Introduction", "Problem Description", "Evaluation of Adaptation Potential", "Analysis of Sectors Response to Climate Changes", and "Summary", plus "References". The document includes one subchapter: "Floods" (7 pages), where six types of floods, including the sea related case, are very briefly discussed. Floods are mainly discussed in reference to heavy rains, river floods and events with the combined effect of extreme sea storm surges and river backwater cases.

The final conclusion from this subchapter reads: "When analysing mathematical models that interpret the physical properties of the water cycle in nature, of which surface runoff is one of the components, the following rule applies: if [temperature increases] and [precipitation intensity increases with warming], then [flood probability increases]. However, the verification of this rule turned out to be problematic. Future climate scenarios indicate the likelihood of increased flood risk in many areas, but observations do not convincingly confirm this. Detecting the impact of climate change on high river flows is not easy, even on a regional scale. The relatively weak climate signal (if any) is superimposed on strong natural variability and non-climatic factors, such as changes in land use. It may take several more decades for statistically significant trends to be detected." (Ekovert, 2021, p. 57).

The above text is in extreme contradiction to the fully established scientific knowledge related to climate change and its consequences, also for the coastal areas. There is also a short discussion run in chapter 4.8 "Tourism", where 2 pages are dedicated to a summary of the overtopping potential scenarios and threats to the Tricity region. In the summary of this chapter the authors of the document see the threat related to sea rising, they mention overtopping, i.e. the overflowing of the seas over the quays as a result of rising water levels in the ocean as well as more frequent storms and increasing the height of the waves. However, this short text is followed by a far more extensive summary on many other climate related threats, such as heavy rains, river floods and droughts. The final summary just generally relates to climate change threats and mostly refers to economic consequences of the potential adverse changes.

The Adaptation and Mitigation to Climate Changes for the OMGGS (Ekovert, 2021) has an Appendix (67 pages) entitled the "Adaptation plan". The sea level rise is mentioned 11 times throughout the text. Four points relate to the overtopping in river deltas, three refer to loss of ecosystems, one refers to the coastal infrastructure, three mention threat to waste collection areas and the consequences. Particular problems are introduced in the text and some examples of good practices in dealing with depicted cases are provided. Then there is a 7.1. chapter (1 page) entitled: "Protection and planning of the coastal touristic infrastructure under the sea level rise pressure". There is a short paragraph dedicated to examples of actions, which include: "spatial planning

allowing designing of touristic infrastructure in areas least threated by overtopping, in a most environment friendly way; designing appropriate protection at the endangered coastal areas." (Ekovert, 2021, p. 40). So, this extended document mostly uses the threat of the sea level rise in terms of the disturbances for the touristic offer and not the existential issue for the entire region.

These findings are in clear contradiction to the situation of many other world coastal areas, where the sea level rise is considered as a real threat and the prevention measures are being introduced. A very good example of such actions is provided by the authorities of Rotterdam and the port management. The port of Rotterdam has a complex website service dedicated to the sea level rise issue and the consequences (Port of Rotterdam, no date). On the website one can find information on the areas which are endangered, the management strategy and the measures taken to deal with the problem.

The Adaptation Strategy of the Port of Rotterdam (Port of Rotterdam, no date a) is the core document of the risk management system. It has 8 pages and is divided into 4 parts, "Climate Change and Flood Risks in the Port of Rotterdam", "What is the flood risk in the Port of Rotterdam", "The adaptation strategy for the Port of Rotterdam", and "What can we expect from the Port authority". Each chapter has its detailed extension under the dedicated online link, provided in the text.

In the very first sentence of the "Adaptation strategy of the Port of Rotterdam" we read: "Sea levels are rising due to climate change and the risk of flooding in the port of Rotterdam is increasing." (Port of Rotterdam, no date a, p. 3). Then it states: "In order to ensure that the port area remains flood-resistant in the future, we are looking into possible flood risks and how we can prevent or manage this to an acceptable level. The programme aims to increase the awareness and sense of personal responsibility of users in the area. In considering various climate change scenarios, we are developing an adaptation strategy for coping with flood risk in collaboration with the Municipality of Rotterdam, other governmental organisations, companies and institutions. We are mapping out the probabilities and consequences of flooding, weighing up the risks and listing and selecting appropriate measures." (Port of Rotterdam, no date b).

It is clear that the approach is comprehensive and multilateral, includes various stakeholders and various levels of decision makers. There is no discussion on the fact if the climate change is a real process and if its consequences are really visible, as it is in the Adaptation and Mitigation to Climate Changes for the OMGGS (Ekovert, 2021). The Port of Rotterdam strategy defines the steps and plans, and sees the importance of stakeholders' awareness of the problem. Most of these issues are missing or are just partially mentioned in the analysed strategies for the Gulf of Gdansk major cities.

CONCLUSIONS

Currently, significant knowledge has been established on climate change related coastal threats (including sea level rise) and their consequences as well as on appropriate management strategies to address these threats.

The authorities of the three major cities in the key Polish coastal region, the Gulf of Gdansk, do not really see the threat related to the sea level rise. The six documents produced for Gdynia, Sopot and Gdansk, including four city developmental strategies and the additional document, with an appendix, directly focused on climate change threats for the region do not mention the sea as a potential threat or the discussion (if any) on this topic is very brief and without concrete definitions and suggestions for preventive tools, mechanisms and solutions. These documents fully disregard the scenarios for sea level rise, which are commonly and easily available, which clearly show that in case of Gdansk, a half a million city, if neglected, the sea will cover entire city centre and its all industrial areas, which will lead to a total collapse of the city as we know it now.

All documents do provide information on climate change related threats, they are listed but most attention is given to riverine floods, heavy rains, high temperatures and droughts. There is no discussion per se, rather a list of possible threats, while adaptation measures are rarely mentioned and the sea level rise and its consequences are neglected or at the best, relate to the touristic challenges. Even the adaptation plan does not really refer to the real existential level of the problem, it simply refers to the threat to the touristic offer of the region.

This situation is surprising, since we have a global consensus on the climate change trends and its consequences, including the threats and threats for the coastal areas. Many communities are already introducing developmental plans with the inclusion of the needs for the adaptive measures to sea level rise. This is not an unknown problem and it seems that various levels of Gulf of Gdansk region authorities must be aware of the real threat. Nevertheless, no real measures are being implemented and still many large scale infrastructures (mainly touristic) are built in the very vicinity to the sea, in areas, which researchers and engineers define as endangered by potential sea related floods. As of now, there are very many loopholes in planning of coastal developments and decisions for erecting touristic infrastructures in the direct vicinity of the beach. Such cases are relatively common and usually rise many public discussions, which sometimes close the construction progress, while in many cases, do not stop the works.

This attitude is disturbing and needs further analyses. Perhaps it is a major lack of climate change awareness, or simply ignorance towards the consequences which are projected for the next decades, so relatively far from now. We strongly believe that the awareness rising actions are necessary and must be undertaken immediately.

The Gulf of Gdansk area is a key regional and global player in terms of cargo shipping and tourism, and thus, with this description we tackle a global issue for denying or not seeing the inevitable, i.e. severe, adverse consequences of climate change for all communities, and especially those which are in direct vicinity of the sea. There is very little time to act and there are a lot of good examples of port cities, which take many preventive and adapting actions and measures to secure their future. These are e.g. Rotterdam, Singapore, New York.

We strongly believe that the local authorities should gain from other good examples and start the planning for the adaptation to sea level rise. The Tricity, has partners in many networks, like e.g. Union of the Baltic Cities or C40 and so, using from experience of other cities would make most sense. The authorities, should establish interdisciplinary teams to tackle the local problem. These teams should cooperate with similar groups

from other cities, which have already implemented some measures to tackle the problem.

The sea level rise and its potentially catastrophic impact on the region must be addressed and the appropriate adaptation plans must be created for the Tricity region. These must be followed by the effective implementation of the defined preventive measures. Such approach is "a must" for the region, not in terms of the touristic offer but in terms of the survival of the local community and vast consequences of the potential catastrophic future events.

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