

Tourism Monitoring in Antarctica - Development of a concept for the analysis of the impacts of tourism on the assets to be protected in the Antarctic

Aim of this document

This discussion paper serves as a preparatory document for the discussions in the working groups. It outlines the findings from a comprehensive literature review on the development of tourism in qualitative and quantitative terms and impacts on the assets to be protected as defined in the Protocol on Environmental Protection to the Antarctic Treaty. Furthermore, existing and proposed monitoring approaches and management measures were considered. This builds the knowledge base for the work on a comprehensive long-term monitoring concept for frequently visited tourist sites in the Antarctic. Some initial approaches for such a monitoring concept are already outlined in this discussion paper. The detailed findings from the literature review will be published in the project report.

Summary

Rising tourist numbers and the diversification of tourist activities are anticipated to have an increasing impact on the Antarctic environment. The sensitive Antarctic ecosystem, which is already severely threatened by climate change, is exposed to increasing pressure from human visitors. However, a comprehensive knowledge base on the environmental impacts of tourism and therefore on the effectiveness of different management measures is lacking. The German Environment Agency (UBA) therefore initiated a research project to develop a monitoring concept to investigate and monitor the long-term impacts of tourism in Antarctica.

Background and introduction

Antarctic tourism has rapidly increased in quantity in the last decades (IAATO, 2019). Tourist numbers reached a new peak in the 2019/2020 season with nearly 75,000 tourists visiting Antarctica (IAATO, 2021). The upward trend is expected to continue in the coming decade due to new cruise ships coming into service and the climate change-induced extension of the travel season. Besides, new tourism activities are emerging with the diversification of Antarctic tourism (Vöneky & Wisehart, 2016). The Antarctic ecosystem is highly sensitive due to the isolation of the Antarctic continent and the extreme conditions for the evolution of flora and fauna. Human activities in Antarctica, therefore, have the potential to affect and damage the sensitive ecosystem or individual components (Tin et al., 2009; Mayer et al., 2017). While some human impacts are well studied, such as changes in penguin and seabird populations or individual effects on specific species (Regel & Pütz, 1997), others remain unstudied. Due to the lack of a systematic and comprehensive long-term monitoring program, the overall impacts of human activities are poorly understood.

The risks of a further increase in tourism are thus almost incalculable. For many years, Antarctic Treaty Parties have been discussing ways to manage Antarctic tourism efficiently and sustainably. However, this is hardly feasible without a solid data basis on the concrete impacts of tourism activities. In particular, cumulative or indirect effects cannot be identified and specified without long-term monitoring. The tourism study of the Committee on Environmental

Protection (CEP) of the Antarctic Treaty Consultative Meeting (ATCM) of 2012 already gives the recommendation (Recommendation 6) to consider

"establishing an ATCM-approved on-site monitoring program to i) assess the effectiveness of the Site-specific Guidelines and ii) monitor impacts." (CEP, 2012),

To date, however, the Parties have not been able to agree on such monitoring.

In Germany, the protection of the Antarctic environment and its dependent and associated ecosystems is stipulated in Article 1 of the Act implementing the Protocol of Environmental Protection to the Antarctic Treaty (AUG). Despite the exceptional importance of tourism compared to other human activities in Antarctica, targeted regulations for tourist activities are still lacking. Therefore, UBA commissioned a research project with funding from the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection to develop a comprehensive long-term monitoring concept for tourist sites in the Antarctic.

Literature review on tourism in the Antarctic

Documents on the impacts of tourism activities on the Antarctic environment and, in particular, on the assets to be protected according to Art. 3 para. 2 b) of the Protocol on Environmental Protection (PEPAT) have been systematically compiled and evaluated using the structure described below. A focus is also on the monitoring methods used, to assess whether these methods represent the current state of the art and would be suitable for permanent monitoring in the Antarctic. In addition, so-called "citizen science projects" were included in the research and evaluated accordingly.

Methodology

The literature database compiled for the assessment of the existing knowledge base comprises different types of documents, such as books, scientific articles, conference or workshop papers, (project) reports and other types of grey literature such as fact sheets. In total, 130 documents were considered for the analysis.

Overall, the assessment matrix was developed along the DPSIR (Driving forces, Pressures, States, Impacts and Responses) concept developed by the European Environment Agency (EEA, 1999). This model reflects the relations between the environmental and the human system, which are expressed in simple causal relations. The **Driving forces** are social, demographic and economic developments and the corresponding changes, which exert **Pressure** on the environment and imply a change in the **State** of the environment. This in turn leads to **Impacts** on the environmental and human system that may lead to societal **Responses** (EEA, 1999). In the context of Antarctic tourism, the components of the DPSIR framework can be described as follows:

- Driving forces: e.g., climate change, an extension of the travel season, diversification of tourism
- Pressures: e.g. disturbance of wildlife, trampling, littering, introduction and dissemination of invasive species
- States: e.g. species distribution and abundance, the integrity of habitats, pollution concentration levels in the water, soil, and air
- Impacts: e.g. change of behaviour patterns, loss of native biodiversity, damage to vegetation

- Responses: e.g. taxes, environmental laws, certification schemes, environmental monitoring, limits to visitation

In this context, the relevant aspects for the analysis were touristic aspects such as the type of tourist activity, the description of environmental impacts including the duration of the impact and monitoring-relevant aspects such as indicators, methods and links to the assets to be protected. Additionally, possible management measures for the mitigation of negative impacts were also included in the analysis. The main results are described in the following.

Results

Geographical areas analysed

About half of the analyzed documents focused on polar regions or the Antarctic region without specifying the spatial delimitations more clearly. Differences in the local circumstances, however, make it hard to generalize the impacts of tourism on a whole continent. Many documents focus on the highly visited tourist sites of the Antarctic Peninsula. Less research on tourism has been carried out on Ross Island which represents a second key tourist area (Stewart et al., 2005).

Tourist activities - drivers

The three main types of tourism in Antarctica are seaborne tourism, airborne tourism and land-based tourism. Furthermore, different subtypes can be distinguished depending on whether landings on land are included or not (seaborne tourism with or without landings, airborne tourism with or without landings). Most of the documents analysed dealt with cruise tourism or did not specify the type of tourism and focused on human impacts in general. Accordingly, activities such as marine or terrestrial wildlife watching or hiking are well studied. Land-based tourism as such was not explicitly differentiated from shorter landings or the impacts of research activities on the continent. Only a few documents addressed the impacts of aeroplanes and helicopter roundtrips. Cruise tourism is still by far the prevailing tourism type in terms of quantitative numbers, but the impacts of airborne or land-based tourism forms can be higher despite the low number of tourists participating in it.

State of the Antarctic environment

The current knowledge of the Antarctic environment is limited, as most studies focus on single parameters at the local level (e.g. pollution concentration levels, population size and distribution of species, ...). A comprehensive understanding of the different components of the environment and their interactions on a larger scale is lacking.

Environmental impacts of tourism

The environmental impacts of Antarctic tourism are diverse and range from the introduction of pathogens or invasive species to the pollution of air, water and soil, to the disturbance of marine or terrestrial wildlife. However, most research articles focus on the disturbance of macrofauna like penguins which is due to their high abundance at many sites and their relevance as a main tourist attraction (Tejedo et al., 2022). Further topics receiving attention in the scientific community have been chemical pollution, the introduction of non-native species and soil degradation. In contrast, damage to vegetation or the introduction of plant diseases due to tourism has to date largely been ignored. Moreover, some studies do not analyse the impacts of tourism specifically, but of research in the Antarctic or other human activities in general. For effects of trampling on soil and vegetation, the disturbance of macrofauna, the potential

introduction of non-native species and pollution, there is clear evidence for negative impacts caused by tourism. Yet, these impacts have not been quantified and long-term studies to detect cumulative impacts from multiple causative factors are still rare. Studies on penguins, for example, are not consistent regarding the effects of tourist visitation, which is potentially due to species-specific responses, habituation effects and the quality and quantity of human activities. Other impacts, such as the ingestion of microplastics have hardly been studied and remain unknown (Trathan et al., 2015). For whales, the relationship between short-term behavioural responses and their long-term consequences is poorly understood (Arias et al., 2018).

For an overview of pressures and impacts associated with different types of tourism and different tourist activities as well as a possible response and strategies see Annexe B.

Proposed mitigation measures to reduce human impacts from tourism

The literature on Antarctic tourism proposes a broad range of measures to prevent or minimize potential adverse impacts of tourism. One example is the cleaning of clothing and gear to prevent the spread of alien species. However, most measures focus mainly on the local impacts of tourist activities and neglect large-scale and cumulative environmental changes. Given the increasing pressures on the Antarctic environment, the current level of protection is inadequate. Stricter regulations are suggested by several authors, for example concerning the minimum distance to terrestrial and marine macrofauna. Protected areas, like the Antarctic Specially Protected Areas (ASPAs) which currently only cover 1.5% of the ice-free area, should be extended. Besides, better enforcement of site guidelines should be ensured through appropriate supervision of tourists and better education of both tourists and tourism operators and staff. Accreditation schemes and the establishment of standards can contribute to strengthening compliant and responsible tourism operators. To what extent tourists can serve as ambassadors for the protection of Antarctica is discussed controversially in the literature. In general, studies examining attitudes of tourists towards Antarctica found only slight changes in attitudes and a lack of awareness about their own contribution to environmental change. Moreover, the relationship between attitudes and behaviour is complex (Tisdell, 2010). Experiences, interpretations and products need to be changed to actually achieve ambassadorship outcomes (Hall et al., 2013). A viable example is the involvement of tourists in citizen science projects (Cusick et al., 2020).

To ensure that tourism is not having more than a minor or transitory impact on the environment, not only the quality of tourism operations but also the quantity matters. In this regard, stricter regulations and the restriction of certain tourism activities alone may prove insufficient for the protection of the Antarctic environment in the long term. Therefore, the limitation of tourist numbers should possibly also be considered. Furthermore, it is discussed in the literature whether a concentration of tourism to small areas or a more uniform spread is preferable. IAATO and ATC site guidelines indirectly pursue the first strategy. In general, this contributes to restricting the negative impacts of tourism to a smaller area and facilitates the management of tourism. But apart from that, this also risks resulting in an unacceptably high level of cumulative impacts on wildlife in the visited area, which may also negatively impact on surrounding unvisited sites. Furthermore, a perceived loss of wildness impairs the visitor experience. In general, efforts should be made to maintain inviolate areas which can serve as valuable control sites for future scientific research (Cowan et al., 2011).

A solid knowledge base is a prerequisite for proactive management of tourism in the Antarctic. Environmental impact assessments need to be carried out for specific tourist activities, long-

term monitoring programs are important to detect cumulative impacts and large-scale effects of Antarctic tourism, and experiments and comparative studies can provide valuable new insights. Moreover, more detailed knowledge about the effectiveness and possible negative side effects of mitigation measures is crucial. Thereby, differences in the local circumstances also need to be considered. In practice, efforts to reduce the adverse effects of tourism mainly rely on management and barely any legally binding regulations specifically for tourism exist. This needs to be addressed to ensure the protection of the Antarctic environment in the long term.

Annexe B contains three cause-effect relation diagrams presenting in detail the links between drivers, pressures, impacts and mitigation measures. This is based on the findings from the literature analysis as described in the methodology section.

Knowledge gaps

Studies on the impacts of tourism activities are at the most relatively short term, so that interannual variations obscure possible long-term effects. Moreover, most studies on potential anthropogenic impacts on the assets to be protected in Antarctica focus on local conditions and single parameters and cover cruise tourism mostly. In this way, only direct and just in some cases indirect small-scale impacts are recorded. However, it is well known that tourism activities may have long-term cumulative environmental impacts and impacts on wilderness and wilderness values. Cumulative impacts also result from the combination of various factors, each of which may be harmless when considered individually. Permission processes including EIAs for individual activities may fail to identify cumulative impacts. Cumulative impacts and overuse may result in impacts that are not captured by an assessment of the environmental impacts of a single activity.

Overall, despite extensive research, our knowledge is patchy. This concerns especially the functionality of the Antarctic ecosystem with its interactions between species communities or regeneration times of populations across all taxonomic levels. Consequently, there is a knowledge gap at what point humans disturb natural environmental processes (e.g. through the introduction of non-native species, temperature increase, underwater noise, etc.) and what the exact consequences will be for the various components of the Antarctic environment. In this context, potential cumulative effects, i.e., the simultaneous occurrence of several disturbances of different types (e.g., acoustic and visual) or the occurrence of the same disturbance in close succession (e.g., several successive visits of smaller groups of visitors leading to a more or less permanent disturbance) play an important role.

In our literature research, we found detailed information on tourist activities and their impacts on penguins but is the already observable change in abundance and distribution of penguin and seabird populations a consequence of climate change or tourism activities or both or other factors? but less on Impacts on vegetation. The knowledge of terrestrial diversity is limited in many areas and for many taxa. Furthermore, little is known about sound propagation in the various marine areas and passages that are heavily frequented by ships. There are gaps in our knowledge of the exposure limits of surface and underwater noise for cetaceans, seals, birds, or other marine species. Do marine inhabitants get used to noise and visitors or do they react sensitively? Where are the limits and are mitigation methods such as keeping a minimum distance effective?

No doubt, the standard of the ships and onboard operations are critical factors in ensuring safe and environmentally responsible tourism. However, does the classification of ships by passenger

numbers still reflect environmental relevance today? New ships may have fewer emissions in absolute terms. Site-specific visitation limits are also based on the number of passengers. Thus, a few yacht passengers may spend extended time at a penguin colony and potentially disturb more than the total number of all passengers on a cruise ship guided by experienced guides. It is also irrelevant to vegetation whether, for example, a few passengers of a yacht walk over it several times during the day or a higher number of passengers of an expedition cruise ship walk over it once. However, the knowledge of the ecological conditions of many landing sites, as well as the anthropogenic influences is limited and there is a lack of well-founded data. In the long term, we need to figure out, among others, how to account for differences in the local circumstances, what the limits of acceptable change are and whether the spatial concentration or balanced distribution of visitors is preferable in terms of minimising potential impacts of tourism.

In the absence of constant monitoring, there is a lack of information on whether current response measures are appropriate and which response measures would be most effective. As long as there is no conclusive and comprehensive scientific evidence about the impacts of tourism, a precautionary approach should be used to manage tourism. Meanwhile, efforts should focus on establishing a long-term monitoring concept.

Lessons learnt for the monitoring of tourism impacts

The purpose of the monitoring system is to expand the knowledge about the impacts of tourist activities in the Antarctic, but it should also serve as an early warning system to avoid any impacts that are more than minor or transitory. The literature proposes that the findings of the monitoring inform management decisions that aim to prevent or minimize adverse environmental impacts of tourism. The interactions between local impacts of different tourist activities, global environmental change and the environment are, however, complex. An observed impact cannot easily be attributed to a sole cause but is the manifestation of multiple causative factors (Aronson et al., 2011), and some of them may never be completely identified or controlled (Trathan et al., 2008). Environmental impacts do not arise from tourists alone, but also from tourist staff, which also needs to be considered in the monitoring system. Changes are not necessarily linear but can occur rapidly with limited potential for recovery and the validity of predictions building on past experiences is limited (Trathan et al., 2015). Therefore, a precautionary approach is proposed by the scientific community, especially when the knowledge base is not sufficient.

The monitoring system should be able to adequately account for cumulative impacts and habituation effects of wildlife to human visitation. In this wake, it is emphasized in the literature that also less frequently performed tourist activities such as skiing, snorkelling, submarine dives or helicopter flights need to be included, even though they do not represent a majority of tourists yet. Besides, the impacts can vary significantly due to the local context. Human visitation was observed to potentially result in both decreased and enhanced productivity, for example. Consequently, monitoring needs to be site-specific with a focus on vulnerable sites.

The scientific community criticises current management efforts for being inconsistent and uncoordinated. Different actors need to cooperate more closely to effectively mitigate the negative impacts of tourism. This concerns especially stakeholders from the tourism industry, as they play a pivotal role in enforcing operational rules. It is moreover important to address diverging interests and work towards a collective vision, which should also include scientifically

informed deliberations on an acceptable level of impact. Information exchange should be ensured among diverse stakeholder groups to strengthen the link between research and management (Tejedo et al., 2022). The securing of adequate financial resources is a major challenge for long-term monitoring systems. This could be addressed by a contribution of tourism to the costs, e.g. via taxes or fees for tourism. It is furthermore proposed to use the potential of Antarctic tourism operators and visitors and to build on already existing monitoring approaches. The former can be realized through citizen science projects, which have the potential to provide scientifically relevant samples at low costs but are limited to tourist visited locations (Cusick et al., 2020).

Existing monitoring systems often only focus on aspects of shipping, but the impacts are considerably determined by the behaviour of tourists. Tourists' blogs could be a way to close this knowledge gap. More precise information can be gained through the combination of different methodologies. In general, analytical methods with high sensitivity are needed, for example as pollution concentrations are comparatively low in Antarctica (Szopińska et al., 2017). For the impacts on wildlife, it is not sufficient to only focus on behavioural changes (as current management practices do), as these do not necessarily reflect physiological changes (Coetzee et al., 2016). In addition, interpreting behavioural cues is challenging as these can also involve habituation or avoidance behaviour and obscure long-term consequences of a disturbance. Current approaches to monitoring the impacts of tourist activities mainly focus on the local level but neglect the large-scale effects of tourism. This applies to the travelling to the destination and the associated GHG emissions, which are to date rarely considered in environmental impact assessments.

In the selection of adequate monitoring methods, it is important to also account for the adverse effects of the method and to balance the disadvantages with the benefits of the method. One example would be the use of drones, which allow for more precise imagery than remote sensing but cause considerable disturbance to penguins.

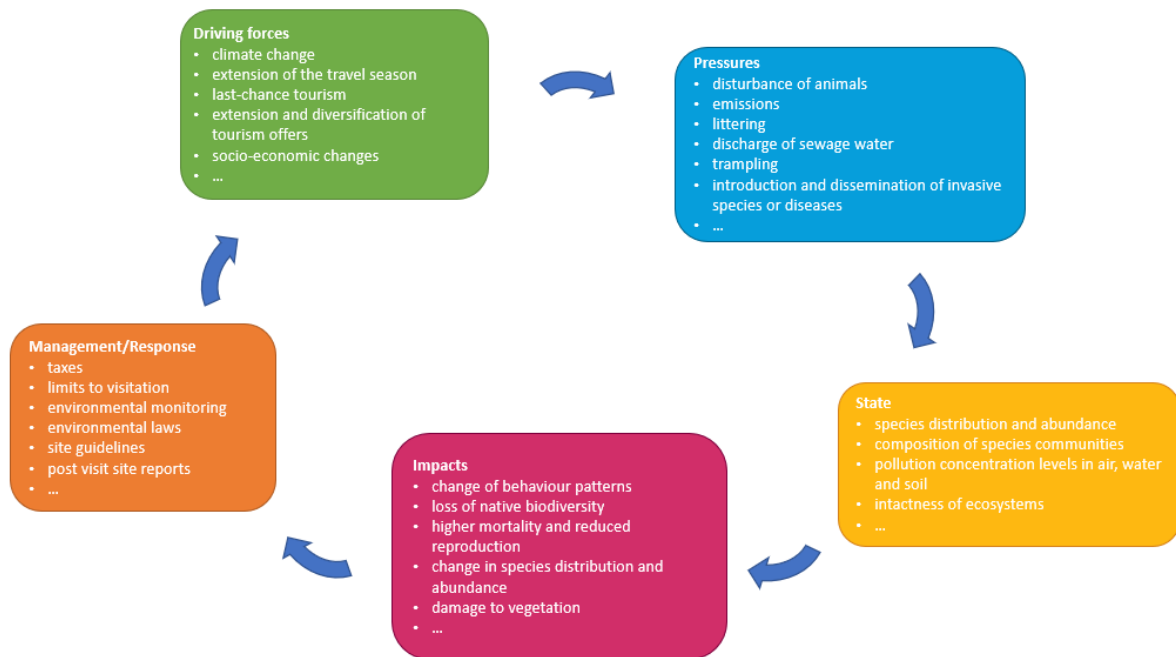
First ideas for a monitoring concept

In the EU, but also at the global level, monitoring concepts that are oriented along the causal chain of variables influencing the environmental quality and environmental protection measures have proven their worth. Therefore, it is proposed to use the DPSIR concept as described above as a basis for the monitoring concept.

As a first step, data and information on all the different elements of the DPSIR (Drivers, Pressures, State, Impact and Response strategies) chain are collected. Then possible connections between these different aspects are postulated. Through the use of the DPSIR framework, it is possible to gauge the effectiveness of response strategies.

Following this approach has the advantage that information on tourism activities (number of tourists, type of trip, tourism activities) can be combined with environmental information (noise, pollution). Through the use of the DPSIR framework, it is furthermore possible to gauge the effectiveness of response strategies, this can therefore form the basis for future management decisions. The figure below shows the first application of this concept for monitoring in the context of Antarctic tourism.

Figure 1: Monitoring concept based on the DPSIR approach.



In a next step, indicators that allow monitoring need to be defined for each of the elements. This would be done based on ongoing activities in order to minimise the effort and to make use of existing long(er) time data sets.

Questions for discussion

For each of the two discussion sessions, a sample of questions has been developed to stimulate the discussions in the working groups.

Session 1: Discuss the results from the literature review (incl. gaps)

Question 1: Were all relevant drivers and environmental impacts identified?

Question 2: Do the Pressure-Impact-Response diagrams cover all relevant aspects?

Question 3: How can knowledge gaps be made explicit and how can they be addressed effectively in the monitoring system?

Session 2: Discussion of the concept and brainstorming

Question 1: Is the DPSIR approach suitable to develop a monitoring concept along? If not, what could be an alternative?/ What are the disadvantages of the DPSIR approach, and how can we mitigate them?

Question 2: Which organisations/institutions should be involved in the monitoring and how?

Question 3: Which role could citizen science play in the monitoring?

Question 4: Which reporting requirements and streams should become along with the monitoring?

Question 5: What are the requirements for the monitoring to be of the highest possible relevance to tourism management (reporting requirements, etc.)?

Question 6: Which other aspects need to be considered in developing/implementing a long-term monitoring concept?

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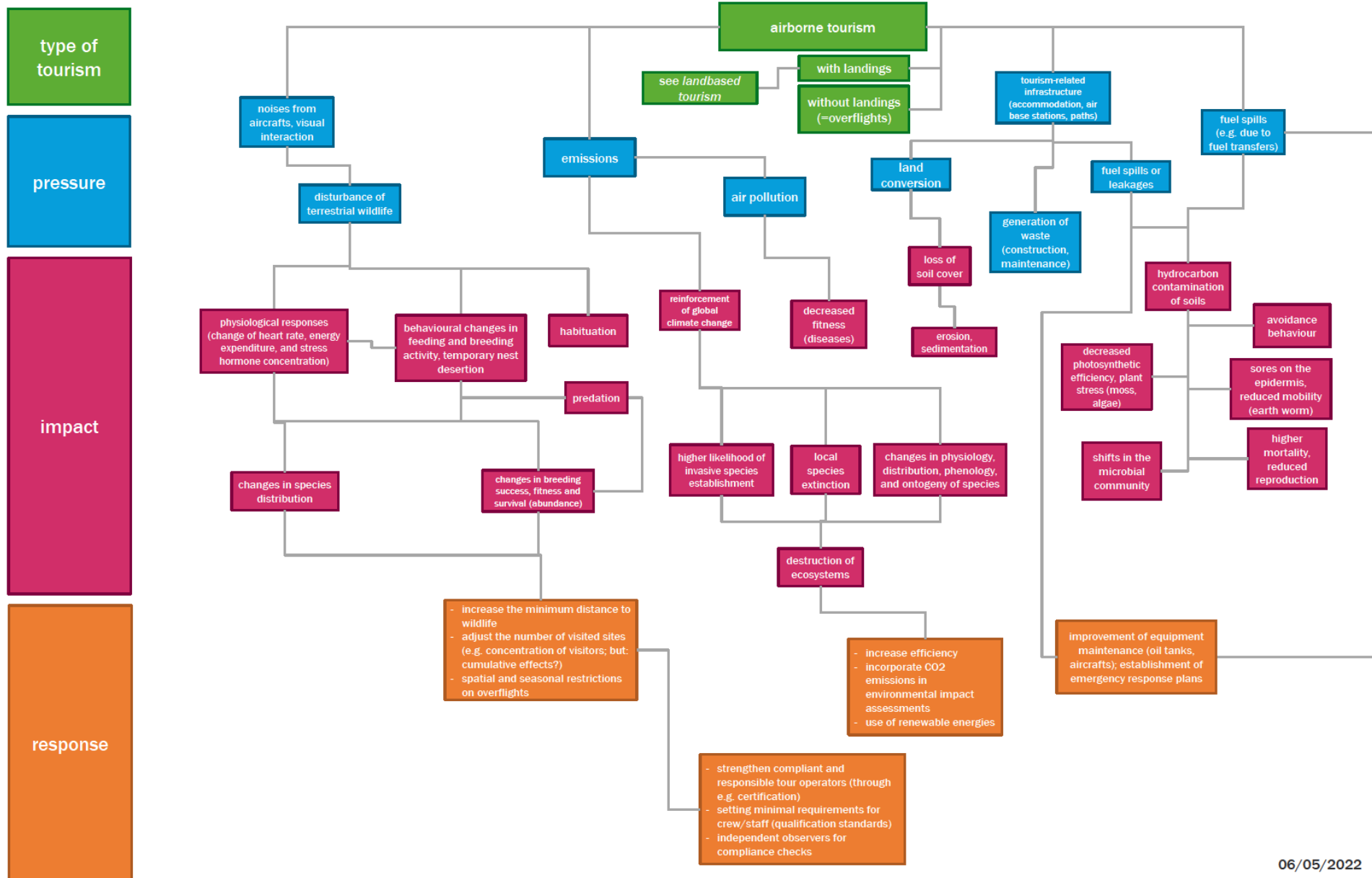
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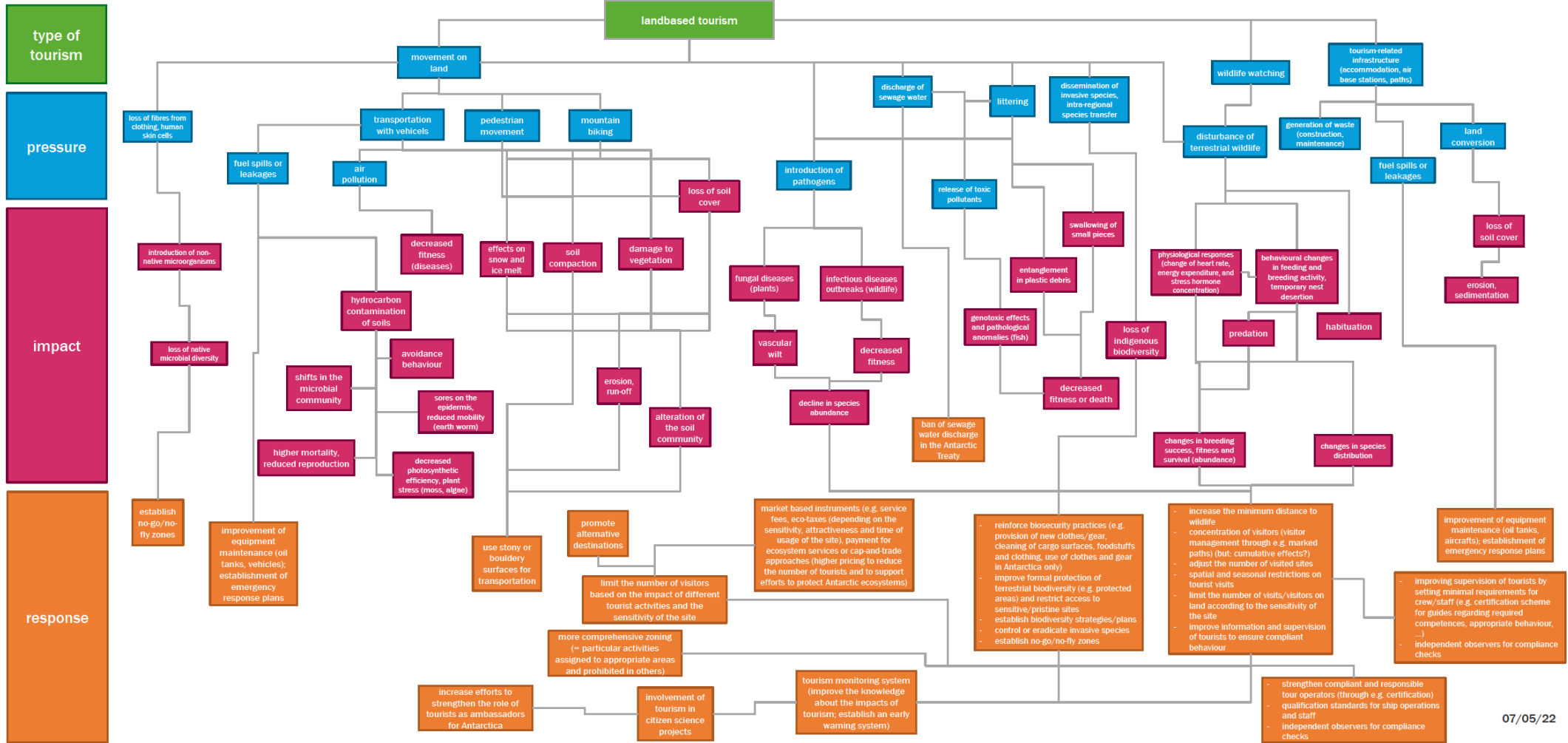
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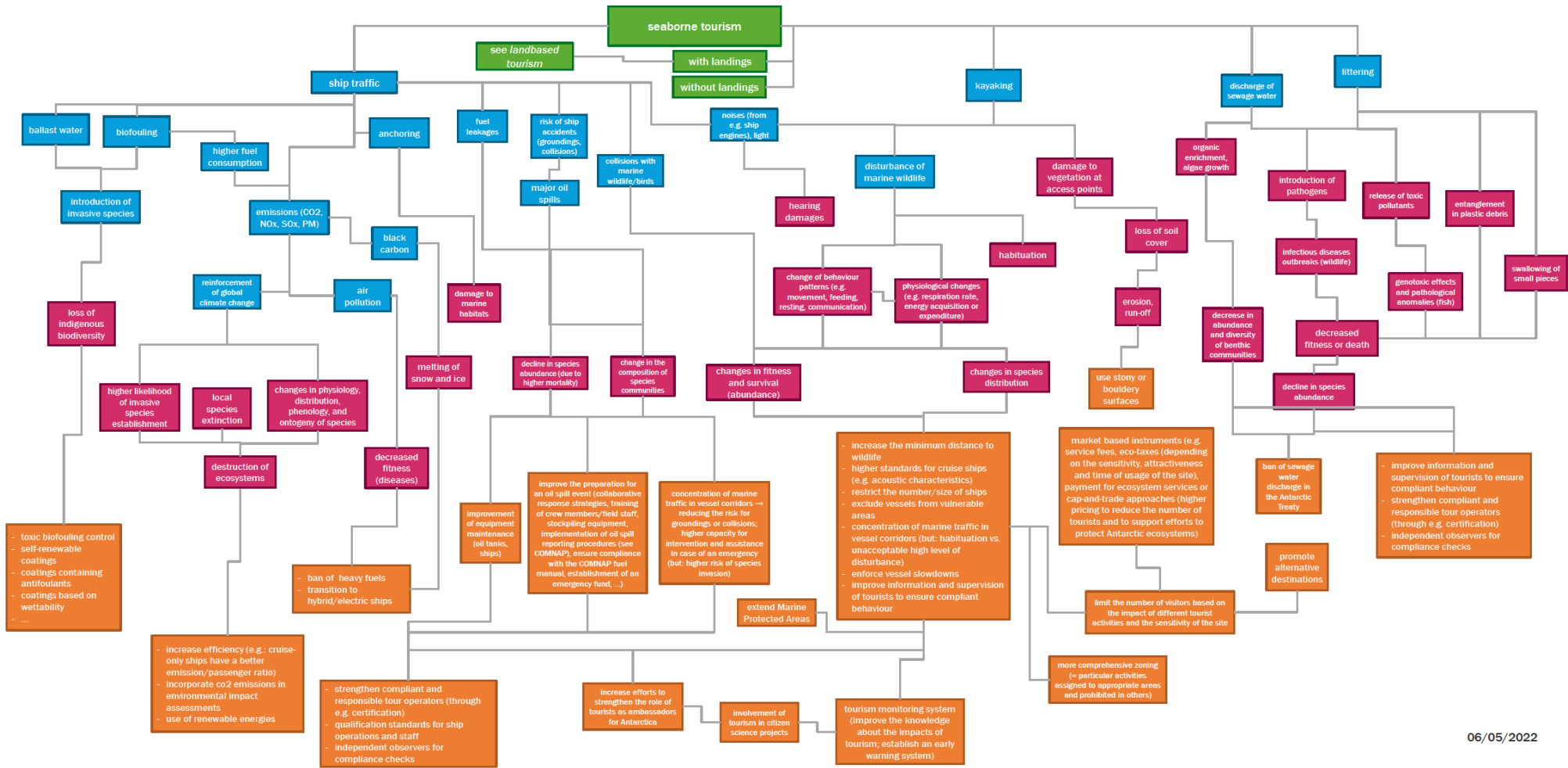
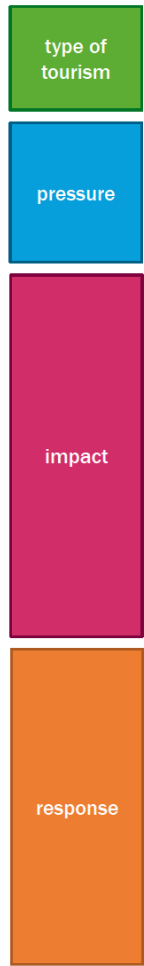
Annexe A: Analysis framework of the literature database

Category	Attributes
General aspects	Number
	Title
	Filename
	Year of publication
	Author(s)
	Full reference
	Short description of the content
	Keywords
	Type of document
	Language
Geographical aspects	Geographical area
	Spatial scale
	Type of tourism (seaborne, airborne, land-based tourism)
Touristic aspects	Type of tourist activity
	Type of effect
Monitoring relevant aspects	Duration of the effect (short, medium, long term), time lag?
	element of the DPSIR framework
	assets to be protected (according to Art. 3 para. 2 lit. b PEPAT)
	indicators
	monitoring methods (e.g. satellite-based monitoring, distance sampling)
	level of maturity (theoretical, under testing, implemented)
	Is the method standardized?
	potential best practice example?
	What issues need to be considered when implementing the monitoring method?
	Provision of operational help for implementing environmental monitoring?
Management relevant aspects	costs
	Management option
	effectiveness
Stakeholder issues	Who was/is involved in the application of the method/tool?
	Involvement of stakeholders from the tourism sector?

Annexe B: Pressure-Impact-Response diagrams







Imprint

Publisher

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Completion: May 2022

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