Comprehensive evaluation of ecosystem service as an object of public interest

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Abstract. The subject of ecosystem services and the assessment of their public investment impacts include a myriad of smaller entities that can be explored in more detail. The aim of this paper is to focus on a group of public investments that are related to the restoration of floodplain and biotopes, as an object of public interest. Nowadays river floodplains enter the theme of public investment primarily as a possibility of renaturation, adaptation or modernization of the territory so that they can be used as a nature friendly flood protection, habitat, but it is not forgotten even for social purposes. The impact of the floodplain as a public investment can make a significant contribution to the region in which it is located. Typical examples are river floodplains, which are unable to absorb flood waves in a given area and thus do not bring social benefits for citizens – even though originating from the above-mentioned principle. Under the condition that the investment is effective, and the project is able to continue to work, it will not only provide assistance in times of floods and an attractive position, but also the benefits of financial resources. If the previous sentence applied to the subject already mentioned, it would be that citizens would come to the region to visit a river flood that is adapted for tourists (cycling path). While visitors do not pay admissions to the public space, it is assumed that they will use the restaurant, accommodation and other facilities in the region, from which the contribution of the state or the region is reversed. Site benefits are not measurable only from a monetary point of view. The output of the contribution is, among other things, a clear definition of elements that should not be neglected, such as safety or ecological, ecosystem, natural, economic, social and educational benefit to the population. Public investments are not only positives. It is also worth mentioning the negative side of the thing, which represents the price that needs to be paid for the implementation and subsequent long-term maintenance of the project.

1. Introduction

The assessment of ecosystem services in public investment is not an easy question. We often encounter the issue of evaluating ecosystem services because, due to their often changing nature, ecosystem services are complicated in terms of valuation methodology. However, the aim of this paper is not to determine the quantifiable value of a particular ecosystem service on site, but to map out potential stakeholders involved in any way in creating a public space where ecosystem services are valued.

In the area of public investment, emphasis should be placed, among other things, on the appropriate appreciation of the investment as a whole, involving a considerable number of stakeholders. A view of a stakeholder investment is very important because it has a direct impact on it and can, as a result, help assess the value of ecosystem service. Therefore, it is very important to map out all stakeholders first and then to identify the impacts (pros and cons) that the investment has on them.
2. Literature review
In order to orientate in the given issue, it is necessary to first define important terms that we meet within the methodology later.

2.1. Identification of ecosystem services
The basic idea of approaching ecosystem services is to bring together people and nature. People and nature interact. People's actions have a direct or indirect effect on nature. Conversely, natural events have an impact on society and its well-being. Thus, ecosystem services provide a direct or indirect economic, material, health or psychological benefit to humans. It is therefore a landscape where nature and people thrive and where they meet and create harmony [1].

Another feature of ecosystem services is the promotion of biodiversity. Ecosystem services are divided into support, supply, regulatory and cultural services. They are all closely related to the various aspects of human well-being. There are support services, such as the water cycle, which maintain conditions for life on Earth. There are also supply services such as food and water, regulatory services such as flood protection, as well as cultural services such as recreational or spiritual benefits [2].

2.2. Restoration of the floodplain ecosystem
The goals of renewal ecosystems must be consistent with maintaining or enhancing their functions. These include, for example, water retention, nutrient accumulation, carbon accumulation, climate creation and maintenance or enhancement of landscape biodiversity [3].

Activities that aim to restore innate ecosystems can be defined as follows:
• restoring the natural hydrological regime
• improving water quality
• bank plantings
• afforestation of meadows and arable land
• grassing of arable land
• renewal of adequate management in today's unused floodplains
• reducing expansive and invasive organisms
• the gradual relocation of buildings and other facilities threatened by floods outside the floodplain

Among the above, it is necessary to explain, inter alia, the notion of restoring the natural hydrological regime. This is a situation where drying and subsequent enlargement of the "land" area occurs [4]. Desiccation is caused by a decrease in groundwater level and a lack of natural floods, resulting in the transformation of the flow into only one stream and climate change. New regulated river beds with dikes prevent regular spring spillage. It also acts as a rapid drainage of water from the landscape and in the summer months it dries up to soil drying and biodiversity wheel [5].

Restoration of bank planting, for example, after the revitalization of its own stream, should be clearly utilized by plants that are naturally in places. This statement should definitely apply in open country, but if we lean into the urban areas - parks in cities, alluvia, other species can be used. Of course, these should be domestic plant species [6].

3. Methodology
The paper presents the situation in a specific defined area, which is the confluence of the Morava and Thaya rivers. Both rivers form an inter-state border in the confluence area, which is also attractive from an international perspective. The confluence of the rivers is characterized by a floodplain forest that defines the rivers. The existence of a floodplain forest corresponds intensively to ecosystem services. The subject of the paper is to define, among other things, the interest groups that would have contact
with the event in the case of the restoration of the selected area - the renaturation of the confluence of rivers [7].

### 3.1. Defining stakeholders

Stakeholder delineation is a very important part of which is often a low level of attention, while the authorities concerned are the starting points for a public interest project and quite often can significantly influence the project. It is in the interest of the project manager to organize a comprehensive stakeholder meeting (workshop), where people from different components of both the public and specific bodies meet. The case study meetings identified stakeholder groups according to Table 1. below.

As you can see below, the event was attended by municipality mayors, experts from the Ministry of Agriculture, Forests of the Czech Republic, Nature and Landscape Protection Agency, CHKO Záhorie, Moravian Fisheries Union, the Ministry of Environment of the Slovak republic, State nature conservancy of the Slovak republic, Slovak Academy of Science, and others. Young representatives of the Slovak Academy of Sciences and Constantine the Philosopher University in Nitra were also present.

| Table 1. Defining stakeholders |
|--------------------------------|
| Target groups                            | Number |
| Local public authority                   | 4      |
| Regional public authority                | 3      |
| National public authority                | 6      |
| Sectoral agency                          | 5      |
| Interest groups including NGOs           | 2      |
| Higher education and research            | 8      |
| International organization               | 3      |
| General public                           | 0      |

Unfortunately, nobody from general public couldn’t attend meeting.

### 3.2. Stakeholder work with the area of interest

The first concrete work of the stakeholders was the mass completion of column E in Table 2. Importance of ecosystem services, which is presented below. Column E, as its name suggests, focuses on the importance of selected ecosystem services relative to the selected area - the confluence of the Morava and Thaya rivers. The table also serves as an overview of individual ecosystem services with descriptions.

After defining the contents of column E in Table 2., the actual definition of individual ecosystem services in the specified area occurred. During the workshop there were some scenario – restoration measures presented to stakeholder, so they could realize the situation before and after. Removal of weirs, removal of summer dike and upper dike at the Czech site of Morava river. Reconnection of old cut oxbows and side channels. Restoration of meandering river pattern and revitalization of the riverbed. Creating a new technical fish pass and new spawning area upstream the weir of Hodonin.

The next step and goal of the workshop was to determine the extent of the used ecosystem services of the selected area for the current state and after restoration. Care was taken to ensure that the
participants in each group were from different interest groups. Each group was accompanied by a mediator.

The participants were divided into three groups of 4-6 participants each and grouped around a large table. Next, the currently used ecosystem services of the pilot area were identified by the stakeholders, written down and the place of use entered in an orthophotograph. The recording and marking of the used ESS in the project area map was done by one participant each. The participants then estimated the extent of the use of the identified ecosystem services. The extend of the use of these ecosystem services has been described by symbols: - - = very low use, - = low use, 0 = middle use, + = high use, ++ = very high use). After a short repeat of the restoration measures of the optimistic scenario, changes of ESS in pilot area were discussed and assessed. Arrows were used as a symbol for the change. An upward arrow meant that the ecosystem service will increase, an arrow down a decrease in the ecosystem service and thus the use of this.

4. Results and discussions

A clear definition of stakeholders and their view of the ecosystem is a very important factor that can influence the course of public investment. From the results of the considered workshop, it was wise that different stakeholder groups have different views on the ecosystem services they carry with them, in the chosen case, the renaturing of the floodplain. The output is thus the link of ecosystem service perceived from the present point of view and the expectation that ecosystem service will bring after renaturation.

What is important is the subjective perception of the situation as a guide for the design and presentation - what benefit do the stakeholders consider to be key and what is the benefit of the project depicted.

One part of the methodology was filling out the last column in the Table 2. Stakeholders point of view on the examined task is visible in the last column of the table - E.

**Table 2. Importance of ecosystem services**

| A | B | C | D | E |
|---|---|---|---|---|
| **Main group** | **Sub group** | **Ecosystem service** | **Description** | **Important in pilot area** |
| Provisioning | Nutrition | Cultivated crops | Agricultural products for consumers | marginally |
| | | Plant resources for agricultural use | Plants used to feed farm animals as a basis to produce e.g. milk and meat | marginally |
| | Wild animals and fish | | | |
| | Surface water for drinking | | Collected precipitation, abstracted surface water from rivers, lakes and other open water bodies for drinking | no |
| | Ground water for drinking | | Freshwater abstracted from groundwater layers or via ground water desalination for drinking | yes |
| Resources | Fibers and other materials from plants for direct use or processing | Wood from forest and plantations for direct use or processing | yes |
|-----------|---------------------------------------------------------------|---------------------------------------------------------------|-----|
|           | Water for non-drinking purposes                               | surface and ground water for non-drinking purposes in industry and agriculture for cooling or irrigation purposes | yes |
| Biomass-based energy resources | Plant-based resources | Plant-based resources from agriculture, short rotation coppice, forestry. Biomass as a resource for energy production. | no |
| Regulating | Retention (Self-purification) | Retention of organic C | Expected without specific data especially deposition of organic C as sediments and removal by self-purification of floodforest |
|           | Retention of N | (Temporary) Retention of organic N by uptake into stationary biomass (e.g. assimilation by mussels or macrophytes) or by deposition as sediments | Expected without specific data especially deposition as sediments and removal by self-purification of river channel |
|           | Retention of P | (Temporary) Retention of P by uptake into stationary biomass (e.g. assimilation by mussels or biofilm) or by deposition as sediments | Expected without specific data especially |
| Global climate regulation | Retention of greenhouse gas emission / carbon sequestration | □ Reducing anoxic ways of C degradation (leading to CH4 emissions) | Expected without specific data especially impact of live or dead biomass of flood forest vegetation and soil |
|---------------------------|----------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                                                          | □ Reducing incomplete anoxic ways of N degradation (leading to N2O emission) |                                                                                                                                  |
|                           |                                                          | □ Retention of CO2 by uptake into biomass by biotic assimilation enabling sequestration of C by a) temporary retention by growth of biomass in river channels and banks (e.g. phytoplankton, annual macrophytes) (with partial trade-off with eutrophication) and b) retention in live or dead biomass of floodplain vegetation and soils |                                                                                                                                  |
| Extreme discharge mediation | Flood risk regulation | Mitigation of flood discharge and lowering of flood peak by inundation of floodplain areas (retention effect) and high roughness of natural river channels (delay effect, which is also broadening the flood wave) | Yes, very important |
|                           |                                                          | Mitigation of drought effects on river flow by a) inflow from floodplain aquifers or b) stabilization of river water level by hydraulic roughness of river channel, which is in some river types additionally increased at low flow by dense growth of aquatic macrophytes. | Yes, very important |
| **Regulation** | Drainage capability | Possibility for water to be drained from an area into a stream channel following a natural slope of the ground | Yes, part of floodplain is net of drain or semi-watered channels, it is so-called inland delta |
|----------------|---------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Sediments      | Mass flow / Sediment regulation | Sediment (incl. suspended) regulation bed load equilibrium and control of channel incision. Adjustment of local surplus or lack of sediment due to erosion or incision or sedimentation (in river channels, floodplains, river mouths, beaches) | yes |
|                | Soil formation in floodplains | Sediment-induced soil formation, favored by sedimentation of suspended particles during floods. | Yes there is important sand dunes with specific habitats used as shelters for wild animals during flood |
| local climate regulation | Local temperature regulation/Cooling | Cooling effect of water bodies and ground due to evapotranspiration in summer | Yes |
| Habitat        | Maintaining habitats | Availability of habitats in typical functional and structural quality, which may be used by typical biotic communities of rivers and floodplains, which may then partially be used by humans | Yes, pilot area is a part of Natura 2000 and Ramsar site |
| Cultural | Landscape aesthetics | Aesthetics of landscape as characterized by its diversity, specificity and naturalness | yes |
|------------------|----------------------|----------------------------------------------------------------------------------|-----|
| Natural and cultural heritage | Entirety of all physical objects (as memorials, species), as well as notional and cultural reflection of physical goods of nature, and informal cultural forms of expression. | Yes, the pilot area is a part of Lichtenstein heritage |
| Unspecific interactions with riverine ecosystem | Experience of animals, plants and landscapes during activities (e.g. hiking, biking) for recreational purpose | yes |
| Water-related activities | Swimming, un-motorized boating, motorized boating (e.g. cruise tours) and fishing as specific water related activities with recreational purpose | No, partly only fishing |

The participants were familiar with the ecosystem expression quite quickly and have had no problems to identify ecosystem services. The evaluation of the extent of the use of the ecosystem services was done quickly, the participants apparently had no major difficulties with it. The atmosphere was constructive. In each group were some very dedicated participants, especially the mayors from the pilot area had a very good knowledge of the area and provided important information.

Stakeholders’ feedback:

- The key method used for stakeholder engagement was mapping and visualization of key stakeholders and activities at the pilot area on an interactive map
- Stakeholders received detailed information and were familiarized with the importance of early stakeholder involvement in general
- The ecosystem services were grouped according to types and the participants visualized these services on the interactive map.
- The participants were able to identify the increase/decrease of ecosystem service benefits before and after the project implementation
- The stakeholders received responses to what, why, when regarding the pilots directly at the workshop.

It is in the public interest to renew and maintain ecosystem, because the function of water retention in the landscape, flood function, biodiversity and others are related to quality. The quality of life of the population living in the region and the continuity, for example, of tourist services, undoubtedly balances the cost of renaturation. The attractiveness of not only the close vicinity of a quality ecosystem will certainly be reflected in the development of small infrastructure, such as cycling trails and prestige of the catchment.

5. Conclusions
The issue of ecosystem services is a complex topic, the scope of which is considerably more demanding than the scope of this work. The factors presented are merely a guideline for regions considering investments in the restoration of river floodplains and other landscape features. The aim was not to comprehensively cover all parameters, but to offer the reader an elementary view of ecosystem services.
Of course, the return on public investment cannot be a priority in the context of ecosystems, but rather a commitment to past generations. With this approach, the Czech Republic can boldly rank among advanced Western civilizations that appreciate its natural heritage and is rightly admired by nations that do not have comparable landscape diversity.

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