



Benefits of green infrastructure - socio-economic importance of constructed urban wetlands (Nummela, Finland)

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Short title: Socio-economic benefits of constructed urban wetlands (Nummela, Finland)

Key Message: Benefits provided by ecosystem services can be successfully integrated into urban planning and management processes. Monitoring of the Nummela Gateway wetland park over a period of three years shows that constructed wetlands rapidly self-establish, resulting in an increase in biodiversity and the establishment of several ecosystem services (e.g. erosion and flood control, and reduction of pollutants in runoff water). The constructed wetland also provides a range of other benefits including opportunities for recreation and education.

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What was the problem?

Land-use changes and management practices within the Lake Enäjärvi watershed (Municipality of Vihti, Uusimaa Region, Southern Finland) have resulted in poor water quality and related adverse impacts such as increased algal blooms and fish mortality in Enäjärvi. Within the Enäjärvi watershed, a 500 hectare sub-watershed, covering 15% of the entire watershed, has been particularly affected by intense land-use, including agriculture and urban development around the Vihti suburb of Nummela. Wastewater from the Nummela suburb had been released untreated into Lake Enäjärvi until 1973 resulting in elevated lake internal nutrient loads, which are still visible today. Runoff water from the urban areas of Nummela and surrounding agricultural areas (parts of which are undergoing urbanisation) was directed into a stream that had - as a result - lost its natural character. Land-use practices within the watershed caused rain and snowmelt to be followed by flashy flows of polluted runoff water into the stream degrading the stream ecosystem. As a consequence, problems such as erosion, flooding, draught, habitat degradation and low water quality were common in the area, preventing local people from accessing and enjoying from their

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surrounding natural environment.

To improve the situation, the existing (unsustainable) means for the disposal of runoff water were examined at the watershed level and solutions were sought through a holistic assessment of watershed processes and dynamics. In order to make informed decisions, the quality and quantity of water released from the watershed were monitored with results indicating a direct impact of land-use practices on both water quality and flows. Based on these considerations, a decision was made to create new wetlands along the heavily degraded stream corridor. The interconnected chain of wetlands was foreseen to form an oasis for both people and wildlife at the heart of the growing suburb of Nummela, while also sustainably managing runoff water before it entered Lake Enäjärvi. A participatory planning process involving the local Keepers of Lake Enäjärvi Association (VESY ry) resulted in the municipality acquiring land along the stream and dedicating it as a “functional” zone for water protection.

Which ecosystem services were examined? And how?

A network of wetlands (i.e. a zone for urban “green infrastructure”) was established along 1.5 kilometres of the degraded stream within the suburb of Nummela including a new 2 hectare wetland park by the lake Enäjärvi, at the mouth of the stream. Several ecosystem services were integrated into the planning, design, and implementation of the zone. Vegetation in the created wetlands was largely allowed to self-establish and only native buffer trees and willow bank stabilisation bundles were planted. Participatory methods were used to integrate the needs of local people into the design, planning and implementation of the project. The stream was first restored and re-named by its old local name Kilsoi. The large wetland park at the mouth of the stream was named the Nummela Gateway Wetland Park, with reference to its function as welcoming both people and wildlife to Nummela.

Regulating services, in particular water purification, erosion control (including river bank stabilisation), regulation of water flow and mitigation of flooding, were taken into consideration when planning and implementing the establishment of wetlands. Wetlands with diverse native riparian vegetation, which support diverse associated microbes important for water purification, as well as diverse insect fauna, which is the basis for rich food webs, were established to ensure appropriate restoration of these ecosystem services. Water quality and flows were monitored to demonstrate positive impacts in practise (see below). Vegetation establishment was monitored to assess success of the chosen self-establishment implementation and as an indicator of biodiversity at the site.

The network of wetlands was also foreseen to provide a range of cultural services to the local public, including opportunities for environmental education and recreation and support to local identity. The wetland areas were made accessible to the public by establishing a network of nature trails. Information boards were created along the trail to provide visual and written information about the ecosystem services at the sites.

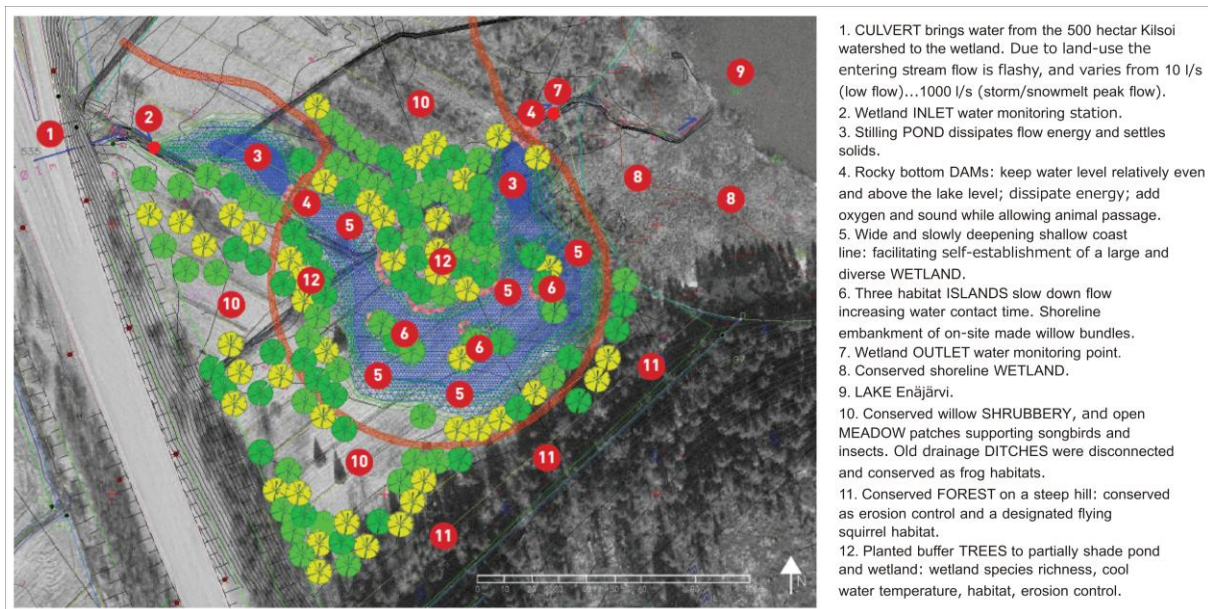


Figure 1. Design of the Nummela Gateway Wetland Park facilitates water purification, flood and erosion control and recreation. Environmental education boards explaining the site's ecosystem services, local flora, microbiota and fauna, are located along the nature trail. Figure by Outi Salminen.

Results

Monitoring of runoff water within Kilsoi watershed revealed clear impacts of land-use practices on water quality and flows. For example, phosphorus rich clay erosion from the tilled and un-vegetated crop fields into the lake Enäjärvi was identified as a typical problem in the area, increasing the risk of algal blooms in the lake. In addition, de-icing salts (NaCl) from urban areas were noted to wash into the stream during snowmelt events, reaching 10 - 20% of the salinity in the brackish Baltic Sea water. Finally, the runoff water also affected the temperature in the stream as water released from urban areas was observed to be on average circa five degrees Celcius higher than the water from other areas. This could have an impact on the species composition within the stream as cold climate fauna can be sensitive to elevated temperatures.

The success of Nummela Gateway wetland park in improving water quality has been closely monitored. The results clearly show that the constructed wetland plays a crucial role in regulating the flow of runoff water and improving water quality within the watershed (Figure 2 below). For example, monitoring for suspended solids shows that the wetland successfully reduces sediment loads to Lake Enäjärvi, even during snowmelt runoff in spring when biological activity of wetlands is low. The reduction of monitored pollutants within the wetland is higher at higher inflow concentrations. The annual monitoring also indicates that the overall capacity of the wetland to improve water quality increases each year as the vegetation coverage increases and matures. Weather conditions throughout the (hydrological) year impact the wetland clean up capacity during snowmelt. For example, heavy and eroding rain events in early winter may saturate the wetland sediment holding surface, resulting in a lower sediment trapping capacity during snowmelt.

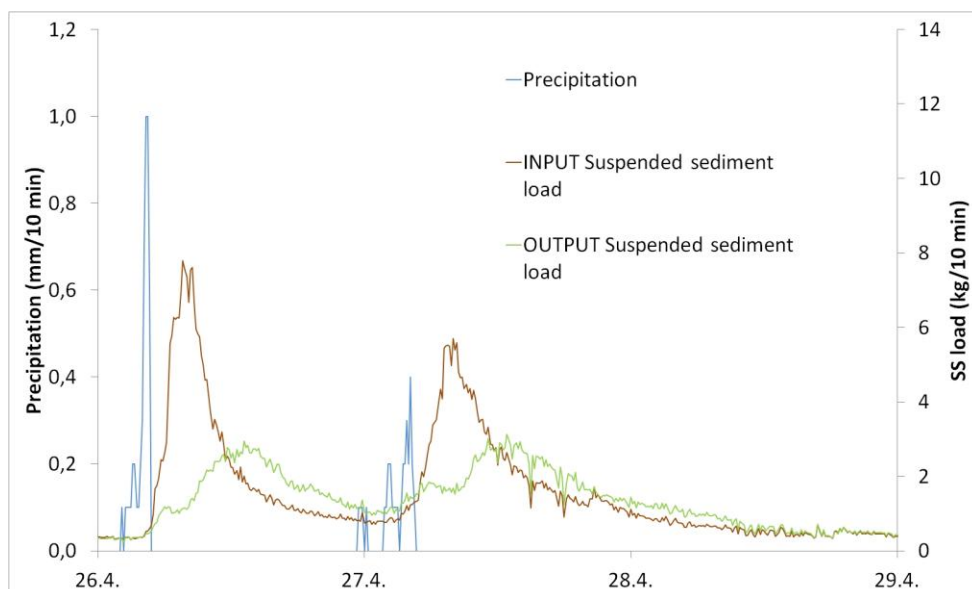


Figure 2. Nummela Gateway Wetland Park reduces the entrance of pollutants such as phosphorus rich clay particles into the Lake Enäjärvi. Monitoring data from late April 2012 (above) show two peaks of suspended sediments following two rain events. In both cases the wetland reduced sediment load into the lake (by 24 and 12%, respectively). During the monitoring period snow had already thawed however the wetland vegetation was still largely dormant. Observed pollutant reductions depend on season, inflow concentration, characteristics of the preceding hydrological events (both recent and over the ongoing hydrological year) as well as design and maturity of the constructed wetland. Graph by Pasi Valkama.

Vegetation was allowed to self-establish with the vegetative succession being monitored on an annual basis (see Figure 3). The monitoring showed a clear increase in plant species numbers on monitored plots: from 57 herbaceous species in the first growing season to 80 species in the second growing season (July 2010 and 2011 respectively). In 2012, the results of monitoring showed that vegetative succession, including competition over light, had commenced resulting in some changes in the species composition at the site: 7 new species had established while 13 species identified in 2011 had disappeared. The wetlands have also become a habitat for threatened frog species and several bird species (e.g. mallard, goldeneye, teal, nightingale and willow warbler). Both the coverage and biomass of vegetation show an annual increase and no invasive species have been found.



Figure 3. A monitored vegetation plot (size 0.5 m²) in the Nummela Gateway Wetland Park in July 2010, 2011, and 2012. Vegetation self-establishment was rapid and vigorous with all native species. A monitored vegetation plot in the Nummela Gateway Wetland Park in July 2010, 2011, and 2012. Species number, coverage and biomass increased each year. Pictures: Outi Salminen and Eeva Vaahtera.

In terms of cost-effectiveness, it was estimated that the costs of enhancing the existing stream corridor and establishing the wetland park were significantly less than the costs of constructing pipe and culvert storm / runoff water drainage systems. The implementation costs of restoring 250 meters of the most severely eroded and altered Kilsoi stream into an open and vegetated stream corridor amounted to 25 000 EUR (total) whereas the estimated costs of conventional conveyance culverts (i.e. pipes allowing continuous flow of runoff water underground) would have been 125 000 EUR (50 000 EUR per 100 meters) at the clayey site. Similarly, the total costs of establishing Nummela Gateway Wetland Park were 62 000 EUR for 2 hectare of park area (including the construction of 1 hectare of inundated area, nature trail, and 125 planted native trees). The estimated costs of a conventional park were 100 EUR / m² (i.e. amounting to several hundred thousands of EUR for 2 ha area). Also, no re-planting of implemented vegetation – which is typically essential for urban parks after the first two years - was necessary, making the one-off costs of the wetland park a cheaper option. Also, the maintenance costs of the wetland park are foreseen to be minimal, including upkeep of the nature trail (annual), and maintenance of wetland meadows and sediment trapping pool (every five to ten years).

What policy uptake resulted / is foreseen to result from examining the ecosystem services?

As a result of wetland creation and the establishment of several ecosystem services (e.g. water purification, recreation and support to local identity) the Kilsoi stream corridor and related Nummela Gateway park have become valued assets within Nummela. In particular, restoring and constructing stream / wetland ecosystems has been found to be a cost-effective means to manage urban runoff water. In addition, the stream corridor and wetland park have created a locally important “multi-purpose” area for both biodiversity and people. Consequently, development of urban green infrastructure in Nummela is foreseen to continue. Further plans for constructing a continuous buffer wetland park along the stream corridor already integrated into Municipality’s land-use plans. In addition, in 2012-2017 the urban landscape in Nummela area will continue to be developed based on further identification of its ecosystem services and combining landscape design and management with environmental protection under the EU LIFE+ project “Urban Oases” (ENV/FIN911). This includes, for example, the development of indicators for the status and quality of water, climate, flora and fauna in the area.

Lessons learned

Benefits provided by ecosystem services can form an integral part of sustainable urban development and functional landscapes providing ecosystem services can be successfully integrated into urban planning and management processes. This case study shows that, when well-planned and carefully implemented, flood mitigation and improvement of water quality through sustainable landscaping can be more cost-effective than technical solutions. In addition, they can provide a range of recreational, educational and cultural benefits. At the same time, the establishment of green infrastructure for ecosystem services can support the creation of connected ecological networks with benefits to biodiversity. This case study also shows how investment in monitoring is needed to support fully informed decisions. It also demonstrates how monitoring helps to verify the outcomes of wetland restoration, this way increasing political and public support.

Participatory approaches and engagement of stakeholders in the design and implementation of the process were found beneficial to long-term success. Collaboration between environmental, planning and technical authorities has been crucial. In addition, the local association for water protection (VESY ry) has been an active partner in the project supporting several voluntary actions. The

Uusimaa Centre for Economic Development, Transport and the Environment (UUDELY) has participated in project management and monitoring from the beginning, providing guidance and support at the regional level. Appropriate technical expertise (e.g. sustainable landscape design and monitoring) has been secured by involving experts from the University of Helsinki, Luode Consulting Oy, UUDELY, and Water Protection Association of the River Vantaa and Helsinki Region. Finally, the Finnish Association for Nature Conservation (SLL) has supported communication and environmental education activities.



Figure 4. Design and implementation of the Nummela Gateway Wetland Park was carried out in a participatory manner, taking into account ecosystem services. The outcome is a diverse and dynamic landscape which provides a rich habitat for local species and a valued oasis for local urban dwellers. Pictures: Outi Salminen

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