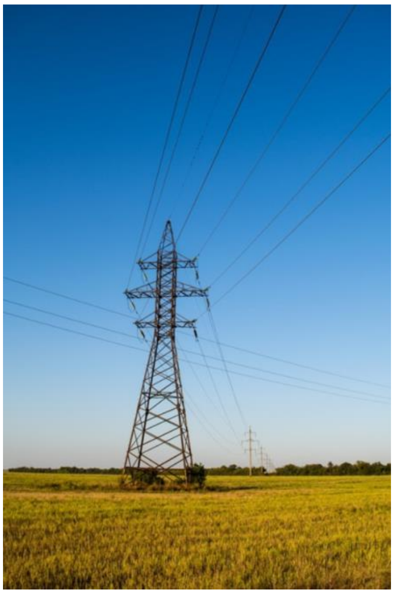
Water Wheel article (Marius Claassen and Liesl Hill)

Water Resource Protection for Development: Linking Ecosystem Structure & Function and Development Outcomes

Olivia wakes up to a sunny day and after a quick shower, she enjoys a hearty bowl of cereal and milk. On her way to school she goes past the factory where her father converts wood to paper. She enjoys the scenic route along the stream, thankful that the previous night's heavy rain didn't flood the fertile valley below. Instead, it filled the dam that supplies the community and the nearby mine, which provides jobs for many people in the surrounding area. The reliable supply of water and electricity at her school enables learners to focus on the academic programme.

This story reflects twelve water-related goods and services. We will explain the relationship between functional water-related ecosystems and the goods and services that they provide in support of social and economic development, but let's first look at the national picture.



According to SANBI[1], South Africa's ecosystem diversity is a kind of infrastructure which, just like roads and railway lines, is critical to the wellbeing of the economy, communities and individual people. The National Development Plan calls for the sustainable management of our natural endowments. One of the principles of spatial planning is spatial sustainability, which requires sustainable patterns of consumption and production, and ways of living that do not damage the natural environment. The second edition of National Water Resource Strategy sets out to ensure that South Africa's aquatic ecosystems are protected effectively at different levels in accordance with the classification system, and that decisions concerning levels of protection take transparent and just account of environmental, social and economic well-being.

The above policies are progressive and aspirational, but the current reality presents some key challenges. The South African national reliable water yield with our current infrastructure is 15bn m^3/annum. However, the current registered water use is 17.3bn m^3/annum. Given that the maximum possible reliable yield is 19bn m^3/annum (if all possible infrastructure is put in place to capture and store water)[2], it is clear that we should focus on more efficient water use. Our rivers and wetlands are also under pressure, with 48% of wetlands critically endangered and only one third of our big rivers being in a good ecological condition. Furthermore, more than 40% of lowland river ecosystems and more than 30% of our lower foothill rivers ecosystems are critically endangered. This decline in the state of water resources has consequences for the health of related ecosystems and for people and economic activities that depend on the goods and services that these ecosystems provide.

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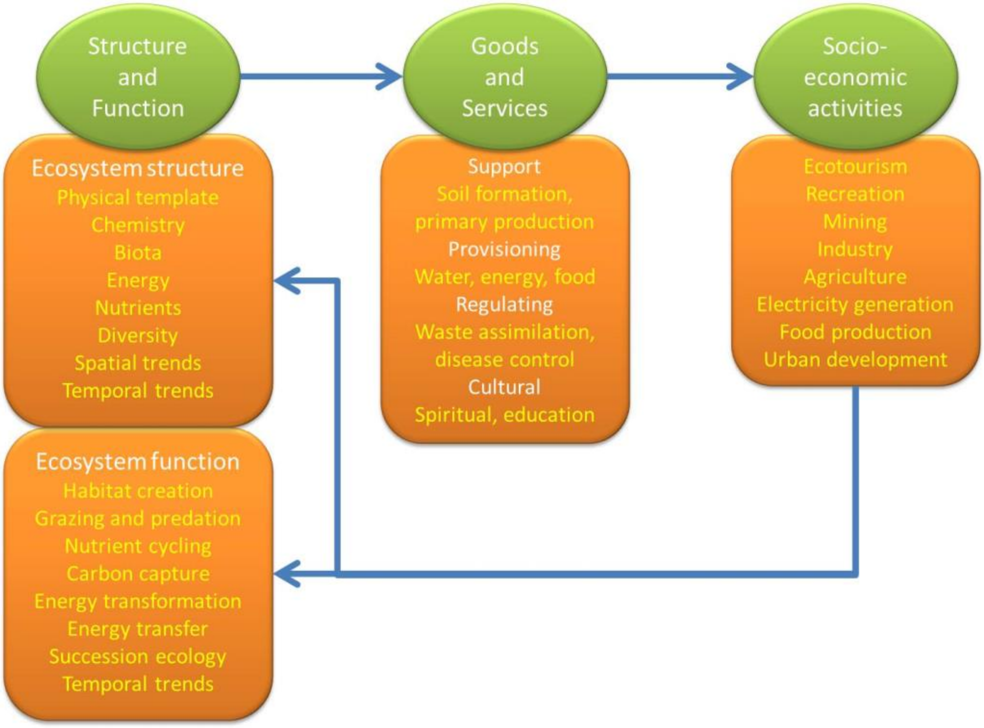
[1] South African National Biodiversity Institute (2013) Life: the state of South Africa's biodiversity 2012. South African National Biodiversity Institute, Pretoria

[2] DWS (2016) Strategic Overview of the Water Services Sector In South Africa. Version 1.7: 18 March 2016 DWS Directorate: Water Services Macro Planning. pp88

It is essential to look at water quantity, water quality and biodiversity, but it is also important to balance the protection of our water-related ecosystems while providing the best opportunities for social and economic development. To enable this, we need a more in-depth understanding of the structure and function of these systems, the associated goods and services, and effective measures to ensure that the goods and services are also available to future generations. In short, this requires “development with nature” and “protection for development”.

The structure of water-related ecosystems refers to the linkages between physical, chemical and biological components. The functional aspects of these linkages are of critical importance to the provision of goods and services. We need to understand for specific systems, how dynamic processes alter geomorphology, how energy and nutrients are converted to biomass, how communities utilise this biomass to grow and proliferate, and how resilient these systems are to change. The seasonal patterns, long term cycles and directional change, due to global change, affect the intrinsic structure and function, but importantly also the goods and services that these ecosystems can provide. For instance, the systems’ resilience to change serves to assimilated waste products, but once this capacity is exceeded, the ecosystem will change to a new state, with different structure and function and thus altering the goods and services that these systems can provide. This could mean that some of the goods and services that people rely on are no longer available.



Goods and services are classically understood to include: Maintenance of the ecosystem; Provisioning services; Regulatory services; and Cultural services. These services depend on the structure and function of the system, which, like industries, power lines and roads, provide the ecological infrastructure for the delivery of social and economic value.

Let's look at some examples of ecological infrastructure and the associated benefits.

Landscapes are physically altered through mining activities (open cast or subsurface), which also affect the settlement and expansion of communities and the establishment of support services. Functioning water related ecosystems can provide a secure supply of water for mining activities and ecological infrastructure, such as rivers and wetlands, assimilate the waste from the mining activities, associated urban areas and support services. The provision of water and assimilation of waste is currently treated as fixed services, whereas the ecosystem structure and functions that support these services are in fact highly dynamic in space and time. If longitudinal connections and seasonal cycles are brought into the equation, we could increase the supply of water and assimilation of waste when and where the ecological infrastructure can sustainably provide such services, whereas the demand for these services can be managed more tightly when and where the capacity of the underlying systems and processes are reduced. Similarly, other goods and services can be utilised more effectively if the underlying processes are understood better. This will for instance reduce the reputational risk for companies where ecosystems respond in unexpected ways to physical or chemical stressors. Water-related landscapes that have previously been altered by mining activities can still provide goods and services, and although the portfolio of socio-economic activities that can be supported by the altered system would be different to the pristine landscape, it can be valuable in providing post-mining social and economic development opportunities. These opportunities can include ecotourism and high-value housing in rehabilitated areas, water provision and waste assimilation for alternative economic activities, agricultural activities in line with the residual risk and opportunities, and supporting biodiversity in specific areas. Thinking of the ecosystems' structure and function as "ecological infrastructure", we also have the opportunity to "engineer" these environments to maximise the environmental and socio-economic benefits. Examples include the protection of blue swallow nesting sites in grasslands and wetland areas (both a conservation and ecotourism benefit), construction and/or enhancement of wetlands (improving biodiversity, waste assimilation, ecotourism and property value) and improved pastures for livestock and wildlife.

Urbanisation is happening at a pace that often puts the provision of basic services under pressure. Urbanites also put a premium on an environment that supports a good quality of life. Given this context, urban waterscapes are a neglected resource. Although it is deemed a source of water and a conduit for waste, these systems are not generally managed to enhance their structure and function and consequently provide a broad range of goods and services. With riparian spaces being confined in urban contexts, we need to understand the dynamic successive processes that create and maintain riparian zones that not only provide excellent opportunities for recreation and increase property values, but also serve as buffer for floods, increase the capacity for waste assimilation and support biodiversity. Again, when we view urban waterscapes as ecological infrastructure that should be integral to the development of urban infrastructure, we can identify the underlying structure and function to enhance intrinsic value and socio-economic benefits. Whereas developers tend to stay away from urban waterscapes that have been turned into waste conduits, the opposite is true for waterscapes that are managed to provide a variety of services. Businesses and residential areas alike will benefit from secure water provision, sustainable waste assimilation, increased opportunities for recreation and aesthetic appreciation. Such conditions will improve property values, improve quality of life, create jobs and improve the overall attractiveness of a metropolitan or municipal area for investment.

The structure and function of water-related ecosystems are of particular importance during drought (and flood) conditions. The resilience of a system to respond to stresses and return to the original state after such stresses, depends on robust structural and functional elements. In this instance, we need to understand the goods and services that are available under stressed conditions, without pushing the system over the edge, thus limiting the ability of the system to continue to provide the goods and services that were available before the drought or flood. The recovery process also involves succession ecology, where there is a transition of species that has a similar function in the system. Merely recording species lists is not particularly useful in this context, where a focus on functional elements will provide a more realistic perspective of development opportunities and constraints.

Getting back to Olivia's story and the preceding perspectives on ecological infrastructure, we can identify the following goods and service:

- *"after a quick shower"* – Provision of household water
- *"hearty bowl of cereal"* – Good quality water for irrigating cereals

- *"and milk"* – Water for livestock watering
- *"the factory"* – Water provision and waste assimilation for industry
- *"where her father converts wood to paper"* – Water for forestry
- *"scenic route along the stream"* – Aesthetic value of water-related ecosystems
- *"rain didn't flood the fertile valley"* – Flood control by intact riparian systems
- *"filled the dam"* – Multi-purpose dams for hydropower, irrigation, potable supplies, recreation
- *"supplies the nearby mine"* – Water supply and waste assimilation for mining
- *"provides jobs for many people"* – Water-dependent economic activities
- *"supply of water"* – Good quality water for social services
- *"and electricity"* – Water provision for cooling at power plants

The above benefits that Olivia is experiencing depend on the underlying structure and function and the effective management of the ecological infrastructure that provide these benefits. In summary, we need to distinguish and understand the importance of ecological infrastructure in natural and modified systems. We will rarely have complete information about the structure and function of a water-related ecosystem, and therefor need to make the best decisions we can with partial information, but embark on a continuous learning process and facilitate feedback loops in an adaptive management process. The end goal is to optimise the structural and functional aspects through an ecological infrastructure perspective to increase goods and services and thus supporting development outcomes. Ultimately we need "protection for development", rather than "protection vs. development"

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