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Neophytes – what will be the future for present Aquatic Floodplain Vegetation?

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The river corridor environment and its aquatic plants

Floodplains are part of river corridors, which – in pre-regulation times – extended significantly in lateral dimension of the river course wherever landscape conditions had allowed. Today most river corridors are constrained by human intervention, especially by systems of levees, mainly serving flood protection. Therefore, waterbodies between the levees, still connected to, or already disconnected from the main channel, are part of the 'active floodplain' environment and undergo periods of high to extreme discharge, but the active floodplain area is usually much reduced as compared to historical conditions. Beyond the levees former river channels and meanders still are present in many locations, but their waterbodies are relicts, which depend on groundwater connection with the active floodplain and on precipitation. Most of these waterbodies have negligible flow, close to still conditions.

The term 'Aquatic Macrophytes' comprises aquatic plant species, even some bryophytes (mosses and liverworts), but usually no algae species. Aquatic plants live submersed (pondweed), with floating leaves (water lily), or free floating (duckweed), but some can live either submersed and/or in very shallow water, and/or on wet substrate, too (moneywort). All plant species which are rooted in shallow water and reach up the shore of still waters or up on river banks, with most of their structures above the water, are 'helophytes' (reed, cattail). Despite the fact that all these plants produce oxygen during light hours, most essentially they contribute to providing structure in the open water (hideout for young fish, cover for predatory fish), serving for food (waterfowl, invertebrates) and offering much space on the surface of their stems and leaves (algae, fungi, protozoa, invertebrates, etc.). This makes them an essential group of organisms in aquatic environments. Non-native aquatic plants, which show 'invasive character', can be called 'Aquatic Neophytes'.

Neobiota – their 'legal environment' defined by EU-Regulation

Aspects regarding invasive species are dealt with the 'Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 23 October 2014 on the prevention and management of the introduction and spread of invasive alien species' (Official Journal of the European Union / L317, EU IAS 2014). Alien species of animals, plants, fungi and micro-organisms are subject of this Regulation, but only where they 'become invasive', show 'adverse impact' on native biodiversity and ecosystem functions, or on social, respectively economic, conditions. EU Member States take liability for preventing the negative effects of invasive species (for detail consult EU-Document L317).

The list of Invasive Alien Species (IAS) is under permanent development, provided that special intensive studies on invasiveness and threat to sensible environments and biota request action against these species. Prevention is the first step of impeding the access of non-native species to EU territory, followed by minimization and mitigation as the next measures on localizing and finally terminating the growth and the destructive effects of IAS. The issue of keeping track of alien animals, as well as plants, fungi and micro-organisms, shows some advantage in detecting plant species, as they do not move around like animals, and usually they are larger than most fungi, and micro-organisms in particular.

Aside from the above mentioned Regulation, other legal instruments of the European Union also take account of biota in waterbodies. Protection, sustaining and even enhancing present ecological conditions for sensitive native biota, including aquatic plant species occurring in waterbodies located in floodplains, active or beyond the levees, are part of these documents.

The EU Water Framework Directive 2000 (EU WFD 2000), amended by the Commission Directive 2014/101/ EU (EU Amending Directive, 2014) explicitly state that all landscape elements depending on surface or groundwater connection with waterbodies, running and still, need to be integrated in any planning for reaching 'good status' or 'good potential' as the goals of WFD.

The focus of the conservation-aimed Council Directive 92/43/EEC (EU Habitats Directive 1992) is assuring the 'favourable conservation status' in protected areas, based on the list of habitats and species. If this status is not met at present, appropriate measures shall be taken.

Additional to balancing and compensating between the – in part – unbalanced aims of the two directives, the required tasks becomes more complicated as many countries of the temperate climate zone undergo a progressive change towards higher summer temperatures and longer lasting periods of vegetation development, as well as lower precipitation rates. This transformation provides important preconditions for non-native species from warm-temperate and subtropical regions of the globe to migrate more effectively into regions beyond the limits of their earlier areas of occurrence.

‚Aquatic Neophytes' – so what? BUT!

‚Aquatic Neophytes', the focus of this contribution, comprise different aquatic plant species which are non-native to the European Countries, with a capacity of invasive growth and capable of replacing native plant species. Many European countries already suffer from heavy infestations by non-native aquatic plants, but not in all locations these plant species are 'invasive'. This term is only used when native plants are suppressed or completely replaced by the new species alien to the respective waterbodies and their surrounding environment and landscape. One of the reasons how alien aquatic species can keep their invasive power is the fact that in their new environments natural enemies are missing.

Figure 1: An example of a dense canopy of the young Pistia stratiotes L. © georgjanauer 2020

In Austria the distribution and abundance of terrestrial neophytes is especially critical along train dams, road margins, and river banks. However, infestation by aquatic invasive species is still at a low level in Austria as compared to other European regions (e.g. W- and S-Europe, and parts of Switzerland and Germany). Navigation canals with slow water flow, reservoirs for irrigation or other human use, but also large fishponds are environments preferred by invasive neophytes.

Natural decay and reduction of established, albeit relatively small areas with invasive aquatic species, is not very likely due to the fact that most of the neophytes referred to below, are regenerated by owners of aquariums and bio-swimming pools, who consider the density of aquatic vegetation to have turned into a nonsensical situation in these waterbodies.

In a small canal in Carinthia (Austria) *Cabomba caroliniana* is present since many decades in slightly thermal excess water of a Spa. *Elodea canadensis* (i.a. highly abundant in 1998 in the Kamp River) and *E. nuttallii* (quite rare, but challenging *E. canadensis)* in a few still and running waters, and *Egeria densa* in thermal spa outlet, were listed by UBA (2002). Additional nine invasive species were listed in several sessions (UBA 2013, 2019, 2020), but mass-development is still rare and local. Therefore no constant management of aquatic neophytes is necessary at present.

But, since cold (and freezing) winter periods are getting shorter and high temperature periods in summer increase in length, conditions for more competitive growth of a greater number of aquatic neophytes can be expected for the near future. Unless particular attention is given to recording the development of new neophyte stands, elimination in large infested areas or just containing the aquatic plants in smaller areas will be almost impossible.

But, what is the situation we can expect for floodplain waterbodies of a large river like the Danube, whose river corridor runs through the Danube National Park, an IUCN-certified nature sanctuary between Vienna and Bratislava? Most of the floodplain waterbodies are relict side channels or oxbows. During low or medium discharge they receive little or no direct flow from their upstream end. They merge with the main channel at their downstream end, where higher discharge or floods can enter causing backflow upstream. Major floods, of course, fill the whole cross section between the levees, and the high banks at the right river side. Some of the long and wider side arms have natural, as well as artificial connections to the main channel, which insure diversion of water at mean and higher discharge in general, reducing the growth of very extensive mass of aquatic neophytes.

But, all more lake-like waterbodies in the active floodplain located in greater distance to the main channel, are especially apt to become invaded by two types of invasive aquatic neophytes: some species (e.g. sub-tropical Myriophyllum species) can quickly fill waterbodies from the bottom of the water surface in less than half a summer period. This considerable increase in structural elements in the waterbody has positive and negative consequences. As shown above aquatic plant biomass provides abundant structure used as micro-habitats for many aquatic animals. Yet, during night hours the respiration of very dense plant growth reduces the oxygen concentration in the water, posing a risk for some aquatic animals, i.a. different fish species.

Another type of invasive plant species, which grow their leaves on floating 'runners' (horizontal stems) or produce buoyant petioles, develop dense and mechanically 'linked' canopies, which attenuate the intensity of light and higher temperature in the whole water body, finally terminating submersed macrophyte growth. On the other hand canopies of native species (e.g. leaves of water lilies) are habitat for amphibians, reptiles, snakes, and insects, as well as for certain bird species.

Figure 2: Young Myriophyllum aquaticum (Vell.) Verdc. and Duckweed species (Lemna sp.); after seasonal development, M. aquaticum can build extremely dense submersed plant stock, as well as aerial vegetation cover. The thin canopy of Duckweed presents no problem for M. aquaticum. © georgjanauer2020

The IAS-list refers to all types of waterbodies, including those beyond the levees, i.a. cut-off meanders, side arms, or manmade waterbodies (e.g. gravel pit lakes), as well as any other still waterbodies, slow running ditches and lowland streams. All these can easily get infested by alien invasive aquatic plants. With relevance to the EU-Regulation, right after detection of any individuals of IAS these shall be eradicated, as the first measure. The problem lies in detecting such 'first individuals', as they may grow in cover, or among different native plants. Small IAS patches or scattered groups of IAS may be recognised in early stages, and eradication can be a success. Once the infestation of the greater volume or area of waterbodies has taken place total eradication may fail. Confining IAS in certain areas and terminating further spread right there can be achieved in some cases.

But, in contrast to confining or even erasing invasive terrestrial plants the aquatic environment turns out to be a much more complicated arena. Different methods are applied against the progressive growth of terrestrial IAS, i.a. cutting, herbicide application, etc. Yet, at least in EU-Member Countries the application of any type of biocide is banned to apply in and close to waterbodies. This leads to introducing mechanical methods, or when needed, manual eradication techniques. Mechanic treatment in waterbodies needs cutting devices on boats or land-bound excavators for pulling submersed and canopy-forming plant species out of the water. 'Semi'-aquatic species can cover or even extend beyond river banks, spreading over adjacent low-land where the combination of several methods may lead to success.

The probably most adverse part regarding successful management in the water is the fragmentation of the plants when cut or pulled to the bank, which applies to running as well as still waterbodies. Almost every fragment can re-grow to a complete plant, which will later produce a large stand again. Collecting the fragments as best as possible under the conditions of the individual situation is the basis for any control measures. Hand-picking of fragments after the use of mechanical treatment (as e.g. done in Germany), has shown positive results.

The most efficient control practise would be the early proof of evidence of the start of an IAS invasion according to the EU-Regulation. When considering the length of the banks of running waters, or the length of lakeshores in general, permanent control is practically impossible, due to expense of time, labour and financial resources. However, raising the awareness of administration units responsible for all types of waterbodies is the indispensable basis for any counteractions against IAS in waterbodies. Keeping a closer eye on IAS establishment and migration is the only way of controlling the risk of losing substantial parts of the native aquatic vegetation at a limited level.

With regard to the floodplain waterbodies in the Danube National Park between Vienna and Bratislava river bed incision and related decrease of water level in the oxbows and relict channels triggered the progress of reed and other

Figure 3: Eichhornia crassipes (Mart.) Solms. Left: Flower and leaves of E. crassipes (Water Hyacinth) © georgjanauer2020. The lower part of the petioles/leaf stalks is widened with airspaces, providing buoyancy. Right: Solid canopy of Water Hyacinth. © Hans Hillewaert

helophytes into the former water-covered realm of the native aquatic plants. The additional threat of IAS eradicating the native aquatic vegetation should be counteracted with force by the respective public organisations. One important step is a higher frequency of surveying the floodplain water bodies to be on the spot when IAS are starting their invasion, and trying to 'confine/limit/eliminate' as described in the EU-Regulation.

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Editorial note:

for further information on invasive alien species see details of the IAD-Expert Group IAS; see also Trichkova et al. 2017 (in Bulgar.): https://www.esenias.org/files/ESENIAS_Atlas_WEB.pdf

Analysis of the retention potential of restoration measures in Bavarian streams

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Background

The concept of restoration comprises the reestablishment of the natural state of previously anthropogenically altered ecosystems as well as the conservation of unaltered, natural ecosystems (StMUV 2014). This study focuses on examining possible restoration measures for water bodies and the surrounding floodplain ecosystems. It aims to define the possible positive effects these measures may have on the natural retention potential and thereby on flood mitigation.

Every ecosystem is defined by its location through e.g., climate, geology, tectonics, soil, and vegetation. These conditions contribute to local characteristics like run-off behavior, sediment budget, morphology, water quality, and flora and fauna, which all dynamically shape surface water bodies (Jürging 2001). During the past centuries, humans have reshaped most of the running waters in Bavaria to enable land use changes towards cultivation or even settlements. Channel straightening has eradicated many