What's wrong with my river?

How does one tell *what's wrong with one's river*, hydromorphologically speaking, that is? Sometimes the issues are clear at the first glance. For instance, one might commonly assume that a concrete lined channel will have depleted biota and that some restoration work will be necessary before it can reach good ecological status. In other occasions the degradation issues might not be so evident. In such cases, first appearances can be misleading and a few complications may arise.

The recently produced deliverable D3.4 of REFORM, a *Guidance to detect impact of HyMo degradation on riparian ecosystems*, addresses such possible complications and includes guidance on how to identify impacts of hydromorphological degradation on riparian ecosystems. In addition, many of the findings gathered in the document are directly relevant to assessing in-stream conditions. The deliverable is written with end-users in mind and includes a generic 5 step approach to understanding impact. The deliverable includes lessons learned from several good case study examples which illustrated and inspired the 5 step approach.

The history of hydromorphological impacts is written in the landscape and on maps. In this regard they differ from, for instance, nutrient pollution where one must use models to hindcast the pre-impact condition. Good quality maps date back to the early 1800s for many parts of Europe and they will have been updated over time, charting a river's response to hydromorphological degradation. Aerial photographs can supplement map data. The first step of our approach is the assembly of such data to create a timeline for the river. In addition to the purely physical features one can often identify areas of wetland associated with a dynamic interaction between river and floodplain. Some of the changes to rivers in Europe have been so long in existence and so extensive that there is no longer any local knowledge of what the original condition of the system was.

There is another area where hydromorphological impacts differ from nutrient pollution. Hydromorphological alteration (e.g. a dam or a channelized section) may impact a number of different hydromorphological processes. Those impacts can take time to develop, which is another good reason to look at historic data. There are some relatively common syndromes which can be identified. For example, rivers below dams often have reduced flooding, this can lead to vegetation encroachment (see Figure 1) which can be so drastic as to make the river change its channel type (e.g. from braided to single thread). In this and other processes, vegetation can play a key role. Riverine vegetation is not just a biological quality element; it interacts with fluvial geomorphological processes to structure our river habitats.

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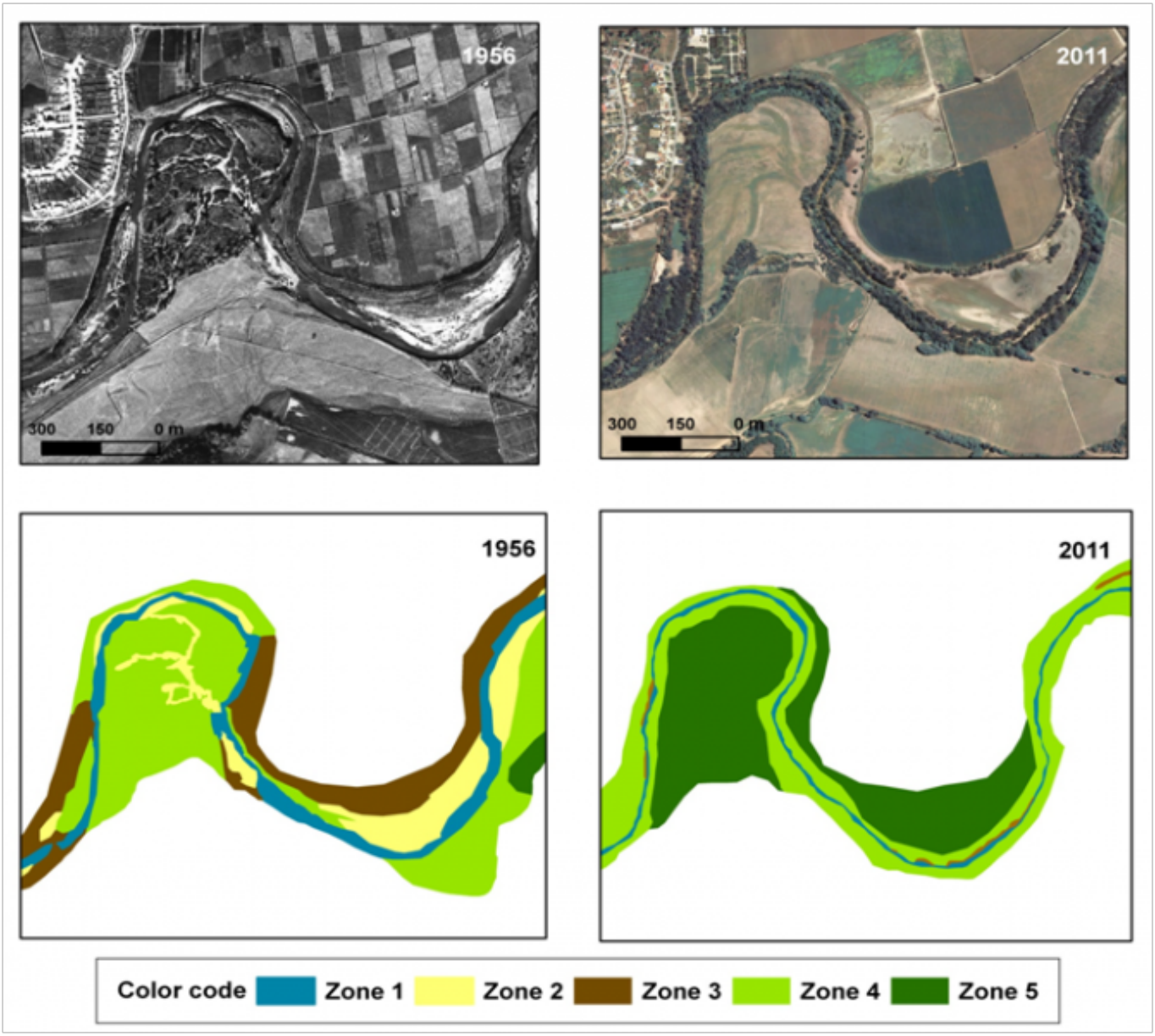

Figure 1. The River Guadalete Spain. The site was subject to damming upstream shortly after 1956. Vegetation encroached. The vegetation zones are based on Gurnell et al. (2014b) and indicate significant differences in the interactions between vegetation and hydrological processes over time (Photographs and diagrams from REFORM partner UPM).

The next step in our plan is to understand the cumulative impact of anthropogenic interventions on hydromorphological processes over time. A key step is identifying what river type one's system would be under natural conditions and what the river type is now.

The next steps include understanding the biota that are supported under natural conditions. For lowland river types in particular one needs to look widely for a biota in good condition, as the changes are so widespread. A decision then needs to be made regarding what is achievable and desirable. That decision can now be made in the context of correctly understanding the physical processes at play. Here we recommend physically modelling the planned remediation, if you have the resources! The details of how one fixes their river must be grounded in a thorough understanding of their system and the steps we describe facilitate that understanding.

REFORM deliverable D3.4 also includes some intriguing studies that deepen our understanding of how diverse biota are supported by hydromorphology. From the Danube delta we learn the

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importance of connectivity between the main channel and floodplain lakes in supporting a diverse fish fauna. Lessons from the Scottish study elucidate how riparian invertebrate communities respond to flooding and riparian vegetation structure. The implications for management of these systems and our other findings are discussed in the report.

As we move forward and more and more rivers across Europe undergo restoration, our knowledge will grow and fresh challenges will be met. For now though there is a simple, if challenging, set of guidelines to work on. To all stakeholders, good luck with your endeavors.

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