CHINA EUROPE Water Platform

CEWP PI Lot1

"Water Management and Ecological Security"

Policy Report for River Restoration practices in China and Europe

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Introduction

Preparatory works: The first contact between University of Évora, Tongji University and China Institute of Water Resources and Hydropower Reasearch (IWHR) was made in 2014 to present a potential cooperation research project in the area of river restoration. During 2014 a series of meetings were held to Identify areas of common interest for the development of a cooperation project.

In May 2014, University of Évora contacted International Relations office of the Portuguese Ministry of Environment to explore the possibility of changing the PT co-lead on irrigation for restoration, ecosystem services and biodiversity. In September 2014 Portuguese and Chinese partners organized and prepared a Forum on a future cooperation project with China in the scope of restoration at the World Water Congress held by IWA (International Water Association) in Lisbon with the live participation of Chinese partners and CEWP. Taking advantage of the presence of the partners in Europe we jointly participated in the European River Restoration Center congress to idnetify potential European partners for the cooperation project that would integrate the experts in the visits to be carried out in 2015.

During November 2014 University of Évora participated in the CEWP Steering Committee meeting by indication of the Ministry of the Environment, which was the first formal contact with the platform where we presented the possibility of leading the co-lead in restoration, ecosystem services and biodiversity jointly with Tongji University and IWHR. The formal acceptance of the change of PT co-lead from irrigation to restoration, ecosystem services and biodiversity and the responsibility of the University of Évora, the Portuguese Ministry of the Environment, Tongji University and Institute of Water Resources and Hydropower Research to encourage cooperation in this field between China and Europe was approuved.

First implementation phase (2015-2016) was developed with the support of DG Environment (trough TAIEF mechanism) to cover the expenses of visiting Chinese experts to European territory to exchange experiences and contacts for cooperation projects. In the frame of this support a Symposium was held at the World Conference of the Society for Ecological Restoration in Manchester, followed by a study visit both in the UK and PT (in this case received by EDIA - visit to restoration projects and fish passage in Pedrogão). TAIEF also supported the participation of Eruopean experts from from PT (University of Évora, Waters of Portugal), FR (ONEMA), DE, AT (BOKU) and NL (Wageningen University) in the 3rd International Symposium on Watershed Science and Health - Wenzhou, followed by a 10-day study visit where it was possible to contact with various regional governments and universities.

Second implementation phase (2017-2018) was developed trough the financial support of Chinese partners. Visits were developed during 2017 (Chinese partners came to Alqueva, Mondego and Touvedo – Portugal). Co-funded by DG Environment and MWR of China, the joint research team visited Nanxi watershed and other areas to present a possible target regions of cooperation. Joint field surveys and technical exchanges were carried out from 2016 to 2018. A policy study was supported by DG Enviornment (trough PSF) on ”Freshwater Restoration standards”, which policy recommendation are summarized in annex I. Some of these measures were further refined in the frame of PI- Lot 1 Water Mangement and Ecological Security project.

The work developed since 2014 until 2018 enabled the co-lead on restoration, ecosystem services and biodiversity to proposed a set of concrete cooperation actions that were included in the PI project of Lot 1 Water Management and Ecological Security, that involve the following main key-areas of cooperation:

- Deep analysis and comparision of river restoration practices in Europe and China
- Development of a joint (EU-China) pilot restoration plan and suggestions for Nanxi Watershed in whenzhou adapting Water Framework Directive methodologies.
- Development of a feasebility study on the implementation of Payments for Ecosystem Services for diffuse pollution control at European watershed in Portugal (which results will only be presented in the end of 2022).
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The works were developed jointly by European (PT- University of Évora, Waters of Portugal; FR – ONEMA; AT - BOKU and NL - Wageningen Universit)) and Chinese partners (China Institute of Water Resources and Hydropower Research, Tongji University, Whenzhou Medical University), with the involvement of stakeholders, water resources bureau, environmental protection bureau, bureau of agriculture and fishery management of Yongjia County.

There work here presented is the result of the following materials produced, under preparation, review or published under the PI-Lot 1 Water management and ecological security:

- Mendes A; Hernandez L.; Badoz, L.; Slobodian L.; Quin T.; Muller H.; Hörbinger S.; Rauch H.P.; Li J.; Bayinbaoligao; Xu F.; Quintella B.; Rabaça J. (**in prep**) Towards a legal definition of Restoration: Using International, European and Chinese legal instruments as case studies.
- Mendes A.; Fabião A.; Lee J.; Bayinbaoligao; Xu F.; Lastname E.; Müller H.; Hörbinger S.; Rauch H.P.; Hernandez L.M.; Badoz L.; Slobodian L.; Quintella B.; lastname E.; XX(fish team); Rabaça J. (**in prep**) The impact of policy drivers in the quality of freshwater restoration projects in Europe and China.
- Feio, M.J.; Hughes, R.M.; Callisto, M.; Nichols, S.J.; Odume, O.N.; Quintella, B.R.; Kuemmerlen, M.; Aguiar, F.C.; Almeida, S.F.P.; Alonso-EguíaLis, P.; et al. The Biological Assessment and Rehabilitation of the World's Rivers: An Overview. Water 2021, 13, 371. https://doi.org/10.3390/w13030371
- Müller, H.; Hörbinger, S.; Franta, F.; Mendes, A.; Li, J.; Cao, P.; Baoligao, B.; Xu, F.; Rauch, H.P. Hydro morphological Assessment as the Basis for Ecosystem Restoration in the Nanxi River Basin (China). Land 2022, 11, 193. https://doi.org/10.3390/land11020193
- Cao, P.; Xu, F.; Gao, S.; Baoligao, B.; Li, X.; Mu, X.; Mendes, A.; Shang, X. Experimental Study on the Impact of Pulsed Flow Velocity on the Scouring of Benthic Algae from a Mountainous River. Water 2022, 14, 3150. https://doi.org/10.3390/w14193150
- JI X; SHU L; CHEN Z; MEI K; XU F; Baoligao B; MENDES A; ZHANG M; SHANG X. Quantitative identification of riverine nitrate sources and uncertainty analysis in the Nanxi River. China Environmental Science 2021,41(8): 3784~3791
- Mendes A; Hernandez L.; Badoz, L.; Slobodian L (**submitted RECIEL**). Towards a legal definition of Restoration: Using International and European case-law as case studies.

They are cited throughout the text.

Key findings

1. *Neither MEAs nor EU Directives or Chinese legislation provide a legal definition of restoration or the relative terms (rehabilitation, requalification, mitigation, compensation). In fact, these terms seem to be used interchangeably, sometimes in complete contradiction of the restorative continuum and without any indication of a reference scenario or the objective that each type of restorative activity should follow*[1].

Our joint works show that the failure to define such terms in Multi Environment Agreements, EU Directives and Chinese legislation results in regulators ordering a form of 'restoration' that may not be appropriate, and in the face of budget constraints, controversies and business pressures, regulators are left alone to define penalties. Legislation rarely articulates the purpose of restoration, thus impeding how to prioritize areas for restoration and the performance criteria to assess the impact of interventions. The new EU Restoration Law under discussion by Member States, does include a definition tough mainly linked to biodiversity objectives.

The debate on how to translate a series of proper nouns such as "Restoration" has never stopped. Due to the nature of the Chinese language itself and the information mismatch in the preparation stage of legal transplantation, the mapping relationship between Chinese and English keywords is not one-to-one, but intersecting and complex, which is even more exarcebated because english use of the words is also confuse.

2. *The quality of the restoration projects is clearly linked to the legal provisions both in Europe and China*[2].

Results of the PI project may already identify possible restoration implications of the different policy drivers that currently prevail in Europe and China. The diverse array of legislative pieces and obligations is set for different types of environmental problems.

The main degradation driver for restoration in Europe was the over-utilization of water resources (21.0%) and in China it was water pollution (29.4%). Another interesting aspect is that with hydro-morphology restoration (28.6%) as the main restoration measure applied in the European projects, as opposed to threats removal in China (30.8%). This is probably due to the different implementation drivers in Europe and China, since the Water Frame-work Directive calls for the need on hydro-morphologic restoration, and in China all the main restoration drivers (1. Construction of ecological civilization; 2. the Three red lines of Most Stringent Water Resources Management; 3. Action Plan for Prevention and Control of Water Pollution; and 4. the Law for Prevention and Control of Water Pollution) call for water conservtion, pollution control and removal.

In Europe, the Water Framework Directive imposes stricter implementation of restoration practices, which includes some ecosystem functions and the need to establish a reference[2]. However, this does not guarantee that results are achieved as our study demonstrates. Another aspect to consider is the absence of a reference scenario in Chinese legislation, which seems to have an impact on quality of projects implemented. When comparing Society for Ecological six atributes (threats, physical conditions, species composition, structural diversity, ecosystem functionality, external exchange) present in EU and Chinese legal frameworks we see that they do not mention all six key atributes hampering the restoration practices, in both geographies.

1 Mendes A; Hernandez L.; Badoz, L.; Slobodian L.; Quin T.; Muller H.; Hörbinger S.; Rauch H.P.; Li J.; Bayinbaoligao; Xu F.; Quintella B.; Rabaça J. (in prep) Towards a legal definition of Restoration: Using International, European and Chinese legal instruments as case studies.

2 Mendes A.; Fabião A.; Lee J.; Bayinbaoligao; Xu F.; Lastname E.; Müller H.; Hörbinger S.; Rauch H.P.; Hernandez L.M.; Badoz L.; Slobodian L.; Quintella B.; lastname E.; XX(fish team); Rabaça J. (in prep) The impact of policy drivers in the quality of freshwater restoration projects in Europe and China.

3. *Both in Europe and China the need to rehabilitate water quality to national standards was driven by several legislative pieces. However, these laws have only general provisions and do not include technical requirements and standards.*

After two decades of WFD history in Europe, the procedure of rehabilitating rivers in Europe remains poorly standardized[3]. From the relatively few rehabilitation projects that have been monitored results show that improvements in hydromorphology can be achieved with small measures in the short term, to improve biological assemblages significantly, large river sections must be recovered and catchment-wide measures and long recovery periods should be expected. Furthermore, success is highly dependent on the design of the on-site measures and the interplay with other measures elsewhere in the catchment.

One successful example is the rehabilitation of the longitudinal continuity of the Mondego River (Portugal), visit by Chinese partners of the co-lead on Restoration, Ecosystem Services and Biodiversity, which was achieved with the construction of five nature-like fish passes and one technical fish pass (vertical slot fish pass at Coimbra Dam). The barrier treatments opened migratory routes and 45 km of habitat for diadromous fishes (*Petromyzon marinus, Alosa alosa*, among others). About 1.5 million fishes are annually recorded using the fishways and a 90-fold increase of sea lamprey larval abundance has resulted from these actions. The rehabilitation was also complemented by the management of related commercial fisheries, including the implementation of an intermediate fishing closure for sea lamprey and shads during the peak of the spawning season. Mondego river example is being used as an example for sucessfull project implementation in China, in Nanxi Watershed, Whenzou, in the frame of PI-Lot 1 projec.

In China, in 1984 the Law on the Prevention and Control of Water Pollution (amended in 1996 and 2008) introduced the need to sustain the ecological function of water bodies in developing, using, regulating, and allocating water resources. The 1988 Water Law (amended in 2016) included: (1) a reward system for the institutions and individuals that make outstanding achievements in the aspects of utilization, conservation, protection, management and prevention of water disasters; (2) the need to consider the protection of the ecological environment when developing hydropower stations, and (3) the need to build fish passage facilities.

The lack of technical requirements in these laws leads to difficulties in implementation and differences in the quality of the rehabilitation projects. Thus, the Ministry of Water Resources issued the Guidelines for Aquatic Ecological Protection and Restoration Planning (SL709—2015) and Technical guidelines for river and lake ecosystem protection and restoration engineering (SL/T 800—2020), with technical requirements for the rehabilitation of aquatic ecosystems.

In addition, China put forward in 2017 national strategies for the ecological protection of the Yangtze River and in 2019 strategies for ecological protection and high quality development for the Yellow River basin, China's second-largest river. The Yangtze River Protection Law, published in March of 2021, is the first legislation of the era of integrated river basin management in China. The protection of the Yangtze River involves the rational allocation, development, and use of water resources. From the perspective of ecological protection, it pays attention to water pollution prevention and control, water quality improvement, water ecological protection, water risk prevention, and water security.

The Plan for The Protection and Restoration of Major National Ecosystems (2021–2035) published in 2020, clarifies the overall requirements and major targets for ecological protection and rehabilitation across the country by 2035. It puts forward key tasks, policies, and measures for major projects, and forms a basic framework for promoting the protection and rehabilitation of major ecosystems in the country.

4. *Biological assessment of rivers and streams is only implemented officially nation-wide and regularly in the European Union. It has been implemented officially at the state/province level (in some cases using common protocols) or in major catchments or at local level in China[3].*

A review of the worlds rivers assessment methods and rehabilitation by PI-Lot1 team has shown that, China has started ecological survey on main rivers since the Twelfth Five Year Plan Period (2010-2015).

From the 1980s until now, a total of 122 large and small Chinese rivers were assessed through national projects (e.g., National High-Tech R&D Program ('863' program), NationalWater Pollution Control and Treatment Science and Technology Major Project, National Key Basic Research and Development Project).

Ecological monitoring practices were undertaken in China since 2012, and the biological indicators included were: algae (number of species, algae cell density, Shannon–Weiner Diversity Index, index of biotic integrity), macroinvertebrates (total number of taxa, EPT-Ephemeroptera, Plecoptera, and Trichoptera, BMWP), and fish (fish species abundance, Shannon Winer diversity, density, IBI).

There are also catchment/province wide monitoring programs, such as that in the Yangtze River (launched in 2005, by the Yangtze River Water Resources Commission), and the Yellow River. According to the latest 2020 Yangtze River Vitality Report, the general water ecological quality of the Yangtze River is grade B, which means unhealthy. The quality levels of river source area, upstream area, midstream area, downstream area are Class A, B, C, and B, repecively.The existing monitoring programs have shown a serious degradation of aquatic ecosystems in several important Chinese watersheds, where up to 85 freshwater endemic species are threatened or endangered.

5. *The well-recognized European MQI method was applied and adapted in a highly modified river system in China by the Nanxi case study of Lot 1, resulting in a plausible assessment of the hydro morphological river status quo. Furthermore, the results function as an internal differentiation concerning quality elements and pressures of the river system. Pressures were identified and can function as a basis for future restoration planning[4].*

Our results support the use of Morphological Quality Index (MQI), and the parameter set defined to identify the most stressing pressures acting upon the Nanxi river basin and suggest that restoration planning should include measures targeted at improving river continuity (either due to small or large dams/weirs or due to crossing structures that reduce river space) and establish natural river vegetation.

The prevailing hydromorphological conditions in the Nanxi river basin strongly require restoration measures and changes in river management to counteract the effects of present degradation and habitat loss. Moreover, there is an obligation to act referring to reach the goals set in the 14th Five Year Plan for Environment Protection, and Chinese legislation, and other frameworks.

3 Feio, M.J.; Hughes, R.M.; Callisto, M.; Nichols, S.J.; Odume, O.N.; Quintella, B.R.; Kuemmerlen, M.; Aguiar, F.C.; Almeida, S.F.P.; Alonso-EguíaLis, P.; et al. The Biological Assessment and Rehabilitation of the World's Rivers: An Overview. Water 2021, 13, 371. https://doi.org/10.3390/w13030371

4 Müller, H.; Hörbinger, S.; Franta, F.; Mendes, A.; Li, J.; Cao, P.; Baoligao, B.; Xu, F.; Rauch, H.P. Hydro morphological Assessment as the Basis for Ecosystem Restoration in the Nanxi River Basin (China). Land 2022, 11, 193. https://doi.org/10.3390/land11020193

Recommendation 1: EU and China lead the process of developing a new legal principle and protocol on river ecological restoration to be adopted by UN.

There is an urgent need to scale up river ecological restoration at large scale. This will require concerted and coordinated action on the part of national and international policymakers, civil society and the private sector, supported and held accountable by a consistent and well-informed judicial system. Our results show discrepancies in the understanding and use of the term "restoration" and related terms by courts at the international, EU and national levels that might impede restoration efforts[5].

European and Chinese legislation currently have a high set of laws that drive member states and provinces to develop restoration practices. However, the lack of common legal and technical definitions still leaves room for discussion among sectors and for different approaches from different sectors.

Courts and legal actors do not use the term "restoration" in the same way practitioners and scientists do. Practitioners' definitions of "restoration" themselves vary in terms of scope, objectives and baseline or reference scenario. In courts, restoration is often used interchangeably with "rehabilitation", "remediation", and even "conservation".

The understanding of "restoration" differs depending on the context of the case[5]. In cases interpreting conservation obligations, it can be considered part of the definition of conservation. In cases on environmental liability, particularly in the pollution context, it is used in the context of remediation, sometimes interchangeably. In cases on approval of infrastructure projects, restoration is a form of compensatory measure. Language plays a role in understanding of "restoration" and associated terms – the terms can have different meanings in different languages.

In both practitioner usage and legal cases, definitions of "restoration" can differ in terms of the objective, standards and baselines/reference scenario. In some usages the baseline is the existing degraded system, which must be improved. In others, the goal of restoration is to return the ecosystem to the level of a previous healthy state. In still others, the objective is a reference scenario based on the condition of other healthy ecosystems or a model of what the ecosystem would look like had the degradation never occurred. Another objective might be to maintain net biodiversity or ecosystem service values in the context of past or planned degradation. The term "restoration" might imply a need to achieve a particular result (which may or may not need to be "significant"), or just to involve particular activities. These differences appear both in the practitioner discussion and in cases at the national level.

Europe and China are strongly committed to restoration objectives as we can see by the new EU restoration law under consultation in EU MS released this year (COM 2022/0195 – 22.06.2022) and by the New Master Plan for National Key ecosystem protection and restoration major projects (2021-2035). We suggest that this could be the **appropriate momentum to jointly produce a new legal international principle and protocol on restoration targeted not only to Nature Conservation, but also other environmental law**. We suggest that all terms should be clarified, and performance indicators should be included as well as application rule. Attorneys and prosecutors should have well established scientific principles embedded in the law. We strongly support Cliquet et al[6] suggestion **that a new legal principle and protocol on ecological restoration should be developed** and that SER standards can play an important role in the development of the International Legal Principle on ecological restoration.

This recommendation would constitute a big achievement in the UN Decade of Restoration and could be jointly presented at the UN Water Conference!

[5] Mendes A; Hernandez L.; Badoz, L.; Slobodian L (submitted RECIEL) Towards a legal definition of Restoration: Using International and European case-law as case studies.

Work on the development of joint "Principles for ecosystem restoration to guide the United Nations Decade 2021–2030" has already started in 2021, but a more legal moldure should be considered as well as strickter indications on the way forward.

1.1 Constitute a multidisciplinary and International expert team[1,6]

If we wish to "Halt and Reverse Biodiversity Loss and Put Nature and Ecosystems on a Path to Recovery by 2030" we must bare in mind the role of judges and prossecutors in the application of International, European and Chinese law. As such, additional analysis (to the ones developed jointly in the frame of Lot 1 Pi project activities) based on an extensive case law collection and legal assessment must be conducted, by multidisciplinary teams, to identify and further clarify these challenges. Target analysis to reply to the following questions are priority: How are the reference/baseline defined? What are the terms used and their content application? What key SER atributtes are considered? How are responsibilities identified and assessed in a context of historical pollution involving several polluters? How are restoration costs estimated?

1.2 Clearly state the objectives, baseline/reference and key atributes to be used in the International restoration protocol[1,6]

The legal definition of ecological restoration should be aligned with the most authoritative scientific principles and standards on ecological restoration in order to effectively achieve global sustainable development goals. This definition must also take into account legal principles and consider the distinction between the objectives of restoration. Our results support the need for international clarification of the legal understanding of ecological restoration and related terms.[6] This is important not only in the context of legal frameworks related to nature conservation, but for any case involving activities or disturbances that could compromise ecosystem integrity, such as development or pollution. A legal definition of restoration and related terms should lay out which attributes should be considered when restoration is needed/mandatory and which reference should be used, which may depend on context.

According to most autoritive science[7] the following six attributes should be included in legal instruments: threats, physical condition, species composition, structural diversity, ecosystem functions, and external exchanges.

Reference definition should be aligned with the sector: 1) Nature - the reference seems to be the status of the ecosystem at the time of listing the site and the objective is to achieve or maintain a favorable conservation status of natural habitats; 2) Pollution - the reference seems to be the status of the ecosystem prior to the pollution event. In the later, the lack of information can interfere in the degree of restoration to be mandatory. We suggest that in the absence of information, a native reference ecosystem for the site should be considered and at least the SER level 3 of restoration should be attained.

Discrepancies in judicial understanding of the concept of restoration may result from a lack of adequate definition of restoration in legal frameworks at the national and international level. Developing a shared understanding of the meaning of "restoration" (or the different meanings applicable in different contexts) could help improve restoration objectives in a number of ways. It could make court decisions more consistent across jurisdictions and give private and public actors more legal certainty about their obligations. It could enable better measurement and monitoring of achievement of restoration requirements at the project, national and international scale, and inform more appropriate, measurable and achievable commitments and standards. This in turn could make legally mandated restoration more effective at achieving conservation goals.

[6] See: A Cliquet, A Telesetsky, A Akhtar-Khavari and K Decleer, "Upscaling ecological restoration: toward a new legal principle and protocol on ecological restoration in international law" (2021) Restoration Ecology 1.

1.3 Develop an efficient pathway to create a global shared understanding of ecological restoration[6]

There are a number of pathways to creating this shared understanding of ecological restoration. One would be through international development and adoption of a legal definition of restoration, through an international decision or resolution. This could involve setting up an international working group, either independent or under the auspices of an international body like IUCN or UNEP to elaborate and refine a definition. The definition would then need to be adopted by one or more international regimes, such as the UN General Assembly or the UN Environment Assembly. To ensure a harmonized definition across sectors, it may be important to work towards adopting the definition by a number of different regimes, including multiple MEA COPs. Further elaboration of the definition of restoration might involve development of a guidance document on the legal definition of restoration at the international level (e.g. by the CBD). Finally, a stand alone international agreement or declaration on restoration could create a strong legal basis for achieving global restoration goals.

1.4 Ensure capacity building in legislative and practitioners value chain[6]

Adoption of a legal definition of restoration is only the first step: such a definition would need to be implemented. This will require building the capacity of judges and policy-makers to understand scientific/practitioner meaning of restoration and developing an interface between scientists and legal actors.

Recommendation 2: Jointly develop restoration standards, norms, certification schemes and guidelines for application in Europe and China.

Standard methods detailing the technical requirements for successful projects are lacking. The China Europe Water Platform is a reliable mechanism for cooperation and joint sharing of knowledge that can promote catalytic processes that may overcome current failures of the European and Chinese legal framework and implementation process. Considering the policy context and data gathered during PI project, we recommend the following:

2.1 Joint development of restoration standards that take in consideration International Standards for the practices Ecological Restoration[7] (SER).

Jointly legally define the following terms: restoration/restore, rehabilitation, requalification, remediation, recovery, mitigation, incorporating SER six key attributes.

2.2 Joint development restoration norms (and certification schemes) to be applied by practioners in a voluntary basys.

2.3 Joint development of guidelines to assist policy makers on granting restoration projects in rural and urban contexts.

2.4 Create transcontinental teams to elaborate and improve technical guidelines for implementing biological monitoring programs and river restoration and establishing common financial and technical frameworks for managing international catchments[3].

[7] Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Ei-senberg C, Guariguata MR, Liu J, Hua F, Echeverria C, Gonzales, EK, Shaw N, Decleer K, Dixon KW. 2019. International principles and standards for the practice of ecological restoration. Second edition. Restoration Ecology S1-S46

Various forms of sustainability standards such as certification schemes, voluntary corporate initiatives, public-private partnerships have become an institutionalized approach to sustainable management (Visseren-Hamakers et al., 2012), and may be used by institutions as reinforcement and soft law mechanisms that will certainly make their contribution to freshwater ecosystem restoration.

Recommendation 3: Improve EU financial system for restoration practices[2].

When we look to financial resources and time involved from problem identification to resource allocation and restoration project implementation, we can see that in Europe project implementation is a lengthy process (5 year), whereas in China the time from project design to implementation is smaller (1 year). That is probably related with the urgent need for pollution control, as was the case of past European environmental legislation (major accidents directive, 1996 – related to SVECO environmental accident), because water pollution control is the first step for environmental problems resolution. However, Europe should pay attention to this result and develop an adequate policy mix that allows reduction of the time of detection of restoration need to implementation. Improving mainstreaming of funding sources (coming from different sectors) for different restoration needs maybe a way forward, as well as, improving the access of Regional Development Funds to finance regional environmental restoration problems.

Recommendation 4: Improve assessment and restoration practices[3]

4.1 Implement large-extent and long-term monitoring programs to monitor sucess of restorative practice both in EU and China

Pre- and post-rehabilitation ecological monitoring data are rarely available, meaning that there is insufficient ecological and historical information regarding the effectiveness of various types of rehabilitation projects. The use of DNA biological samples and eDNA to investigate aquatic diversity could contribute to reducing costs and thus increase monitoring efforts and a more complete assessment of biodiversity.

4.2 Develop a PRC nation wide biological assessement of rivers

Properly define the biological elements and monitoring methods and metrics that should be used nation wide. Despite the Ministry of Water Resources issued in 2015 the “Guidelines for Aquatic Ecological Protection and Restoration Planning”(SL709—2015). This requires monitoring fish, aquatic mammals, benthic invertebrates, epiphytic algae, phytoplankton, aquatic vascular plants, waterside vegetation, beach vegetation, amphibians, reptiles, wetland birds, and rare, endangered and endemic species. The assessment indices include predictive models and multi-metric indices but the latest is more widely used in China for both diatoms and macroinvertebrates. The 14th Five Year Plan for Ecological Environment Monitoring was issued by Ministry of Ecology and Environment in early 2022. The plan includes to establish a unified technical system for aquatic ecological monitoring, to guide the river basins to study and establish water ecological monitoring methods, indicator systems and evaluation methods according to the physical, chemical and biological integrity requirements, to preliminarily form a national water ecological monitoring network based on the river basin, and to carry out water

ecological monitoring and evaluation step by step by classification, zoning and grading. Joint cooperation in this process could benefit both regions.

4.3 Develop a nation wide hydromorphological protocol[4]

4.3.1 Develop specific Chinese hydromorphological assessment method4

The MQI proved to be a suitable basis for the development of non-European hydromorphological assessment methods. Especially in highly impacted river basins, such as the Nanxi River, where restoration measures are necessary, the monitoring function should be given high priority.

4.3.2 Compare results from other methods aplication4

Tough adapting the MQI method in Nanxi watershed had significant challenges, the adjusted approach used a small amount of input data and did not require specific equipment. The application and testing of other methods is recommended, as the comparison of results and feasibility may lead to knowledge enrichment.

4.4 Establish rehabilitation needs, defining clear goals, tracking progress towards achieving them, and involving local populations and stakeholders are key recommendations for rehabilitation projects.

While minimal awareness and technical knowledge among water managers and decision-makers may hinder the implementation and effectiveness of rehabilitation projects. Furthermoresocial/community constraints are often barriers to achieving the desired ecological outcomes.

Typically, projects are focused on local stream sites or reaches; however, those areas are also often limited by upstream water quality and flow regime limitations. Well-established targets are missing or inappropriate regarding both structural and functional ecological indicators.

4.5 Increased public education regarding the importance of river ecosystems and their ecosystem services

The public should be at the forefront of this effort because governments are often responsive to public pressure when formulating their restoration agendas. Finally, much clearer connections between routine biological monitoring and restoration are necessary. Citizen science and river chief systm or river keeper system may bring added value.

Recommendation 5: Consider Nanxi River pilot restoration plan, further refinement and implementation

Nanxi River restoration plan definition and works has been substancially impacted by Covid-19 travel restrictions as biological monitoring of the watershed was only possible in one year and it was not possible to conduct all the necessary monitoring to adequatly define the restoration areas, that is, the areas where the different measures should be applied. Having this in mind, **we strongly suggest that future cooperation projects joint assessment and monitoring practices are conducted so that a refinement of Nanxi restoration plan can be properly developed.**

Despite these constratints, the joint research teamcan already propose a set of measures that are still under discussion and prioritization (see annex II). Nertheless, we can already

strongly suggest that Nanxi restoration plan should include measures targeted at improving river continuity (either due to small or large dams or due to crossing structures that reduce river space) and establish natural river vegetation[4].

The high number of small hydropower plants in the Nanxi River system and the fact that these are obsolete in some cases calls for a detailed assessment of these structures and the development of a conversion plan to improve river hydromorphology and freshwater ecosystems[4].

Implementation of ecological flows and fish passes in the cases where dams are unavoidable is also mandatory if restoration goals are to be achieved[4]. Considering the requirements in the fish feeding grounds in the middle and upper reaches, it is suggested to have the pulsed flow releases from dams to reduce nuisance periphyton growths for the benefits of fish feeding sources.

Sediment excavation and deposition are no longer permitted in Nanxi (according to Yongjia County Government (2016)) though it must be considered that stronger surveillance and governance mechanisms could contribute to change local behaviors of direct collection of riverbed sediments. The River Chief system may play an important role in detecting illegal sediment manipulation[4].

The prevailing hydromorphological conditions in the Nanxi river basin strongly require restoration measures and changes in river management to counteract the effects of present degradation and habitat loss. Moreover, there is an obligation to act referring to reach the goals set in the 14th Five Year Plan for Environment Protection, and Chinese legislation, and other frameworks[4].

Annex I
Policy recommendations proposed in ”Policy study on freshwater restoration standards” (2018)

*Supported through PSF

Type of measure	Description	Region to implement
Governance	Development of legislation that initiates, supports and guarantees ecological restoration.	Europe and China
	Development of restoration standards that take in consideration International Standards for the practices Ecological Restoration (SER doc).	Europe and China
	Development of guidelines to assist policy makers on granting restoration projects in rural and urban contexts.	Europe and China
	Development of guidelines for reference sites.	China using past European experience
	Define the term restoration/restore legally, incorporating ecological functions.	Europe and China in cooperation
	Ensures long-term capacity for ecosystem maintenance through monitoring, intervention, and reporting.	Europe and China
	Ensures continued commitment through legislation and good governance.	Europe and China
	Development of monitoring system and database for resources and ecosystem	China using past European experience
	Development of institution or mechanism for assessing status and tendency of ecosystem and restoration projects	China using past European experience
Quality	Strives to ensure that ecological restoration focusses on protection, rehabilitation and restoration of natural ecosystem's structure, function, composition and dynamics (e.g. perturbations, retrogressive or progressive succession) within the constraints imposed by medium to long-term changes in other words strives to ensure ecosystem resilience over time.	Europe and China
	Ensure that restoration projects respect local and native flora to control genetic pollution.	Europe and China
	Consider the introduction and definition of provenance region of vegetative material (or seed zone)	Mostly China, but also European MS using accumulated experience from MS

	Discourage the use of concrete/cement on river banks. Stimulate the use of natural materials that replace concrete. Develop code of good practice for the use of concrete in river banks.	China and Europe
	Develop guidelines for protection and development of riparian vegetation and for biodiversity protection and enhancement.	Mostly China in cooperation with Europe
	Encourages a minimum level of intervention.	Europe and China
	Avoids adverse effects on ecosystem components, cultural heritage resources and socio-economic conditions.	Europe and China
Stakeholder measures	Takes advantage of synergistic partnerships. Develop process of collaborative learning in local communities. Perform/stimulate stakeholder-mapping helps to understand the relationships and possible issues of conflict in order to organize the action in a most suitable way for all involved parties.	Europe and China
	Develop working group/platform that involves designers, developers of projects, practitioners, and academia so that guidelines are used Nation-wide.	Europe and China in cooperation
	Implementation of Stakeholder involvement practices so that regional adaptation is taken in consideration as well as local community needs.	China using accumulated experience from Europe
Publicity	Raise public awareness on the importance of improved standards.	China and Europe
	Give awards to reinforce good restoration standards. River Prize model.	China and Europe
	Promote citizen science for data collection and monitoring of restoration projects.	China and Europe
	Provide opportunities for people to connect more deeply with nature and enhances their understanding and appreciation of the relationships between cultural and ecological patterns and processes.	Europe and China
Research	Develop typologies of rivers so that they become reference for restoration; development of concepts should be feasible and operable.	China in cooperation with Europe
	Fosters creativity, innovation and knowledge sharing to ensure best future science and practice.	China in cooperation with Europe
	Measures and technologies for freshwater restoration	China in cooperation with Europe

Annex II
Proposed set of measures for Nanxi Watershed ecological restoration plan

(under construction and discussion)

CATEGORY OF MEASURE	ACTIONS	Details
Institutional and regulatory framework	Legal instruments	Penalties definition
		Definition of fiscal entities and surveillance system
	Include policy recommendations in Five Year Plan	Ecological flow definition by hidraulic infrastructure
		Strutural changes in the management of agricultural land
		Define of sand extraction areas according to human and biodiversity needs
		Define the limits of industrial discharges: Shoe/textile/metal
		Define plan for mini-hidric removal - non efficient/obsolet
		Define the limits of captation protection areas for public use
		Define navigable areas and touristic boat according to biodiversity needs on spawning areas
Water quantity	Control of water abstractions	
	Construction projects impact and compensation measures definition	
	Ecological flow definition	
Risk management and enhancement of the water domain	Land acquisition by the state	
Water quality	Control of emissions	Infrastructure renowal/
	Good practice Frameworks/codes	
	Retention and water Treatment station system improvement in the watershed	
	Strutural intervention in the poultry and other animal farming areas	
	WTS construction/requalification/optimization	
	Rehabilitation/Restoration projects	
	Green buffers in agriculture landscape	
	River vegetation buffers	
	Remove garbage collectors from river margins	
Hydromorphology	Removal/adaptation of transversal structures	By type
	Definition of ecological flow	
	Soil bio-engineering techniques	
	Fish pass optimization and fish bypass instalation	
	Definition of sand extraction zones	
	Restoration of river margins physical structure and erosion control	
Biodiversity	Recovery of natural fish populations - restocking?	
	Soil bio-engineering techniques for river habitat diversification	
	Exotic species control?	Survey for possible introductions and development of plan for exotic species
	Cutting and seeding of natural riparian vegetion	
Ecossistem services	Riparian restoration projects	
	Forestry recovery where necessary	
Monitoring	Fish pass monitoring	
	Implement a IoT mechanism for collection of water parameters	
	Analysis of the possiblity of hydric longitudinal connectivity re-establishement	
	Define periodic ecologic monitoring network and methods	
	Define surveillance network - River system	
	Adaptation of fish pass to adequate conditions for monitoring	
	Establish cooperation protocols with scientific and research institutions for development of joint reseach on fish biodiversity and protection	
Research and knowledge	Research projects - sand impact on river bed; ecological flow; habitat for fish/ayu	
	Study on flood control and adaptation to climatic extremes/events	
	Complementar study on the pressures and impacts	
	Development projects - mini-hidric impact and viability of alternative energy sources - plan for mini-hidric removal and replacement	
	Training for natural vegetation propagation	
	Definition of dam operation plans according to biodiversity and ecossystems needs	
	Use of LIDAR technology for accurate flood areas delemitation	
	Demonstration projects - soil bioengineering techniques	
	Development of Nanxi watershed management plan	
Governance	Adminstrative instruments	
Communication	Education projects for fishermen	
	Education projects for children - awareness raising	
	Agro-environment - Awareness raising campains for farmers for nutrient management - pesticides and fertilizers	
	Develop River chief App for local engagement and citizen Science	
	Manual of good practices for River Chiefs	
	Awareness raising on the importance of native species and problems of exotic species introductions	
Economic and finantial framework	Economic instruments	
Other		

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