# Nature based solutions for flood retention in Southern Europe

*30 January – 1 February 2019, Coimbra (Portugal)*

WORKSHOP DOCUMENTATION

COST Action CA16209
Natural Flood Retention on Private Land (LAND4FLOOD)

*"We must build dikes of courage to hold back the flood of fear"*

*Martin Luther King, Jr.*


**Local Organizers:**

Carla S. S. Ferreira

*Research Centre for Natural Resources, Environment and Society (CERNAS), Agrarian School of Coimbra, Polytechnic Institute of Coimbra, Portugal*

Sandra Mourato

*School of Technology and Management, Polytechnic Institute of Leiria, Portugal. ICAAM - Instituto de Ciências Agrárias e Ambientais Mediterrânicas, Universidade de Évora, Portugal*



The workshop was funded by the COST Action "Natural Flood Retention on Private Land" (CA16209). COST is supported by the EU Framework Programme Horizon 2020.

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# NATURE BASED SOLUTIONS FOR FLOOD RETENTION IN SOUTHERN EUROPE

## 1. Framework

### 1.1. Mediterranean floods and management challenges

Southern Mediterranean countries are exposed to increasing environmental challenges, such as desertification (driven by, e.g., the exodus of rural areas and agricultural land abandoned), wildfires, land degradation and water resources degradation. Some of these problems are linked with soil erosion, which lead to siltation of dam reservoirs and other hydraulic infrastructures, triggering the reduction of their drainage/retention capacity and enhancing the vulnerability of these countries to floods. In recent years several Mediterranean countries had to cope with severe flood events and according to climate change forecasts, those events will increase in frequency, intensity and magnitude, leading to a higher number of deaths, injuries and economic losses.

The EU Floods Directive requires that the Member States identify the flood risk zones in their inland waters and coastal areas, taking into account the risks related to climate change, and to take action to minimize those risks.

Grey infrastructures, such as pipes, pumps, ditches and detention ponds, have been used over the last decades to manage storm water and mitigate floods. Nature-based solutions (NBS), however, provide additional runoff storage/infiltration capacity relevant to address climate change impacts on future floods, while support other ecosystem services, e.g. biodiversity conservation and enhancement of air quality, with relevant benefits for the society. NBS provide positive and "no regret" actions, as they bring about combined benefits for sustainable development.

In face of increasing flood hazard, more and more cities, regions and countries are choosing NBS to mitigate and adapt to climate change. Nevertheless, in Southern Europe, investment in NBS is still not yet at the topmost priorities of policy makers and authorities. Global society must be taught to demand their political representatives to invest in NBS in order to minimize vulnerability for future flood events. However, more scientific research is also required to assess the efficiency of NBS on flood mitigation hazard, based on small scale projects already implemented in several countries.

### 1.2. Motivation and Aims of the Workshop

This workshop aimed to facilitate knowledge exchange between researchers, practitioners and stakeholders, including flood policy makers, representatives from farmers' associations, regional flood protection agencies/enterprises and local decision makers from Southern Europe. The workshop provided discussions about experiences and challenges to face and mitigate flood hazard, particularly using NBS or the integration of these solutions with conventional structural/grey measures. Potentialities and constrains of current policies and legal instruments to prevent and mitigate flood hazard were also discussed, together with methodologies to better engage stakeholders and compensate private land owners for flood retention services.

## 2. Water management and riverine conservation in Central Portugal: Field trip

The field trip developed in Coimbra district (Figure 1) included the visit of several sites, in order to discuss (1) the typical grey infrastructures used to manage water resources, and (2) the implementation of small NBS projects in forest areas subject to recent wildfires.

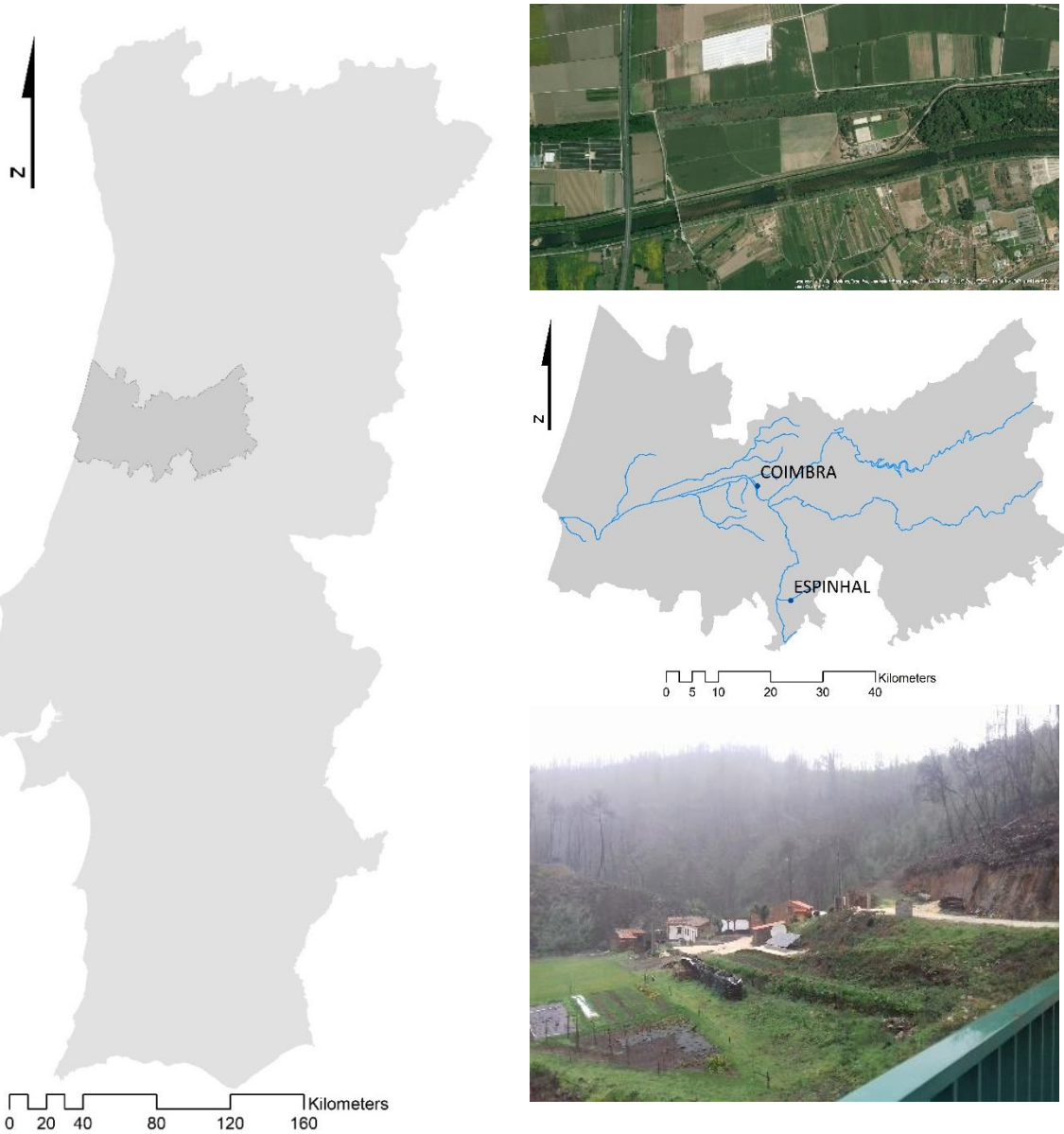


**Figure 1.** Location of Coimbra municipality in Portugal (a), Mondego river in Coimbra district (b), part of the agricultural land parcelling zone of the lower Mondego Valley (c), and site with enhanced flood susceptibility driven by forest fires.

## 2.1. Water management in Mondego river basin

Mondego is the largest entirely Portuguese river. From its spring in Estrela Mountain until the Atlantic Ocean (in Figueira da Foz), Mondego river extends over 258 km, crossing several cities and villages. It drains an area of 6 645 km$^2$, were several floods have been recorded over the last centuries. The most recent foods were recorded in 2001 and 2016, and drove to considerable material damages.

The Portuguese Environmental Agency is the entity responsible for the main water management infrastructures in Mondego river, comprising four dams (Figure 2) and several smaller infrastructures including, e.g., pumping systems and syphons. The dams regulate the flow of ~70% of the basin. This is the main infrastructure responsible for flood management over the last decades and play an important role to manage future floods.

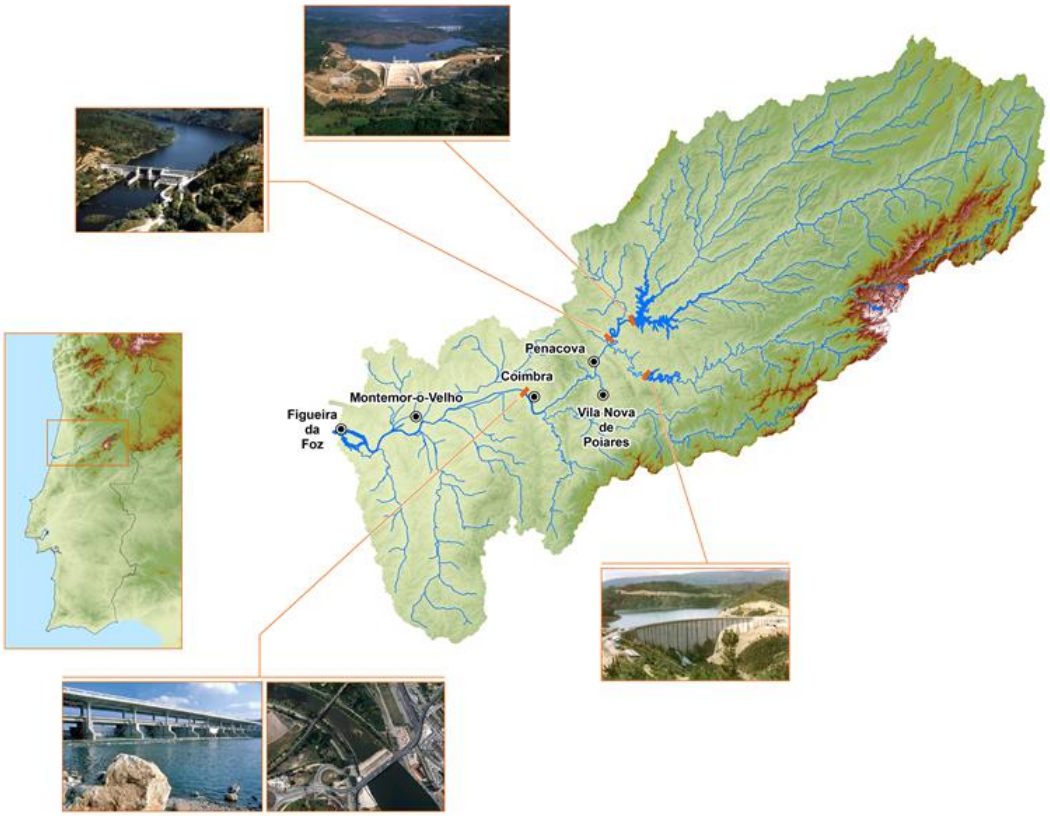


**Figure 2**. Mondego river basin and location of the four dams.

Each dam comprises fish passages to mitigate the impact on aquatic ecosystems (Figure 3). Nevertheless, siltation is an important problem, namely due to reduced drainage capacity of the river. After the most recent floods in Coimbra (2016), local authorities recognized the urgency to dredge sediments and enhance water storage/drainage capacity. Consequently, during 2017-2018, 700,000 m$^3$ of sediments were removed from a 3.2 km of the Mondego river, inside Coimbra city. This project costed ~4 M € and was partially supported by Community funds (POSEUR).

**Figure 3.** Açude dam in Mondego river(a), nearby Coimbra city centre, and associated fish passage (b).

Water management is a rather complex problem, since the authorities have to (1) assure river drainage capacity during the winter, in order to coupe with flows from possible large storms and prevent flood hazard; but, at the same time, (2) guaranty enough water storage capacity to cover the great water supply requirements over the dry summer, particularly for irrigation of agriculture fields and industry, and (3) provide adequate fluvial conditions to maintain wetlands with legal conservation status all over the year (Figure 4).

**Figure 4.** Hydraulic infrastructures used for water management in Mondego river: (a) flow monitoring, (b) area of supplementary water storage capacity (when flows increase from 1200 to 2000 $m^3/s$), (c) secondary channel transporting water for irrigation of agriculture fields, (d) flood gates to protect lowland areas.

The lower Mondego Valley is largely occupied by agricultural fields (private land), extending over an approximate are of 11,000 ha. The area is largely occupied by maize and rice fields. Nearly 6,000 ha is currently equipped with hydraulic infrastructures for irrigation, managed by the Association of Beneficiaries of The Hydro-agricultural project of Lower Mondego, which is in direct contact with Portuguese Environmental Agency. Over the winter, most of these fields are

not cultivated due to great soil moisture driven by elevated water table, and high flood susceptibility. Since farmers were already aware of this problem when they got the land, floods in the fields are faced quite naturally, and no compensation mechanism is required. Most of this area was abandoned and converted into farmland during the 70´s by the former dictatorship.

## 2.2. Riverine restauration

The Portuguese Environmental Agency in Centre Region of Portugal, is strongly committed with riverine restauration. This is considered an important step to achieve the good ecological status of the water bodies, as required by the European Water Framework Directive (2000/60/CE). Following the wildfire tragedy of 2017, when ~2 280 $km^2$ of forest and natural areas were burn (from June to October) in the Centre Region of Portugal (~34% of the territory), the government allocated, in 2018, 4 M € for interventions in the water bodies to increase their resilience, rebalance the ecosystems, plan the riparian gallery and remove exotic species. Part of this budget was used for NBS implementation.

During the field trip, workshop participants observed distinct interventions in wildfire areas. Facing the wildfire tragedy as an opportunity, a huge investment has been performed to cut and control invasive arboreal species (Figure 5). This is mainly achieved by manual work, particularly in river side.

**Figure 5.** Manual control of arboreal invasive species.

There are many different NBS implemented for riverbank stabilization. Some of these solutions include the living grade (Figure 6), which is a wood construction, with box structure, comprising wood trunks arranged perpendicularly. The interior of the structure is filled with stones, until the average water level, and the remaining area is filled with, e.g., local soil and native shrub species.

**Figure 6.** Living grade installed for riverine rehabilitation.

Live fascine is also used for riverbank protection (Figure 7). It consists in a web of live branches of local woody species, placed around cuttings (which can be alive) nailed to the ground.

**Figure 7.** Live fascine NBS for riverbank protection.

Biorolls are cylindrical rolls made of coconut fibre (Figure 8), which allow the sedimentation of materials and/or stabilization of riverbanks. They are used in riverbanks with shallow slopes, and with relatively low variability of water level.

**Figure 8**. Biorolls used to retain sediments and/or riverbank stabilization.

These NBS can be relevant to retain and slowdown surface runoff in wildfire affected areas. In burned hillslopes, the lack of vegetation favour the amount of surface runoff, which can move quickly downhill, enhancing downslope flood hazard. The use of NBS techniques to implement emergency stabilization projects that mitigate flood hazard can favour water resources protection (e.g., water quality of supply sources) and communities (lives and properties) and "jump-start the healing process" across the landscape.

# 3. Lessons Learned

## 3.1. Public Participation and Environmental Sensitivity

The first conclusion of the workshop is related to the importance of public participation and environmental sensitivity. In several presentations, these questions stand up. In some countries, field surveys have been made in order to understand public concerns related to floods and flood mitigation. It has shown to be a good opportunity to present the NBS and the public seems to welcome these options for their potential benefits. If these options are presented to be helpful for flood mitigation (effective and cost-benefit) and provide additional environmental services, stakeholders may feel more comfortable to discuss compensation measures in a bottom-up process. Researchers can provide additional information useful to support decision-making process, e.g., by using available modelling tools to assess the potential impacts of NBS (Figure 9).

**Figure 9**. Technical discussion during the workshop.

## 3.2. Political awareness

The most common driver for political actions is immediately after significant crisis. Participants from different countries mentioned several examples. In Portugal, a huge investment in dredging sediments to enhance the so required storage/drainage capacity of the Mondego River was seen after the major 2016 floods. Relatively high governmental funds were also made available for forest sector after the big wildfires in 2017, which took the life of more than 100 inhabitants in Central Portugal. The small projects of NBS observed during the field trip were implemented with specific funds made available after this wildfire tragedy (Figure 10).

**Figure 10.** Environmental ministry of Portugal and his committee also visit the NBS projects implemented.

If a well-informed public starts small community projects to deal with flood problems and pressure local authorities to support them, a bottom-up approach will be more likely to pressure politicians to canalize funds to a national policy of flood mitigation measures with NBS and compensation schemes.

## 3.3. Implementation of Nature based solutions

Implementing NBS requires cooperation between landscape planners, ecologists, green infrastructure specialists and engineers to make them effective and successful. Green and/or blue infrastructures must be planned to complement current grey infrastructures. Public may feel more safe with public investment in grey infrastructures, and if these ones are complemented with green/blue infrastructures, the confidence of the public can be enhanced, at least during an initial stage, where the public is not used to rely on NBS.

# ANNEX I - PROGRAM

**Wednesday, 30 January**

| | | |
|---|---|---|
| ***14:00 - 14:30*** | ***Welcome to participants*** | |
| ***14:30 - 15:45*** | ***Problematic of floods in Southern Europe, context and main challenges*** | |
| | Urban sprawl in southern Europe and implication for Land Resource Management (water and soil) along the urban-rural gradient | *Luca Salvati* |
| | Historical evolution of flows in Coimbra, Portugal | *João Pardal* |
| | Flooding not everywhere | *Henrique Damásio* |
| | Hydrodynamic modelling as a tool to investigate the impact of nature-based solutions on flood protection | *Sandra Mourato* |
| ***15:45 - 16:00*** | *Coffee break* | |
| ***16:00-17:30*** | ***Projects regarding flood hazard mitigation*** | |
| | Future "Smart and healthy" urban water management, highlighting sustainability under climate change, managed aquifer recharge and European technological water innovations | *João Lobo-Ferreira* |
| | Strategy for the requalification of water courses in the hydrographic basins of the Center Region - Vouga, Mondego and Lis rivers | *Nuno Bravo* |
| | Implementation of natural engineer solutions in river systems: projects in central Portugal and main challenges | *Pedro Teiga* |

**Thursday, 31 January *(FIELD TRIP)***

| | | |
|---|---|---|
| ***9:00-13:00*** | Structural network for water retention and flood protection in Mondego river | *Carlos Batista and António Russo* |
| ***13:00-14:30*** | *Lunch (Arco-Íris restaurant)* | |
| ***14:30-17:30*** | Nature based solution projects in Central Portugal | *Pedro Teiga* |
| ***20:00*** | *Social dinner: Solar do Bacalhau restaurant* | |

**Friday, 1 February**

| | | |
|---|---|---|
| ***9:00-10:30*** | ***Potentialities of nature based solutions to mitigate flood hazard*** | |
| | Nature based solutions in urban areas: relevance for flood hazard mitigation | *Carla Ferreira* |
| | Flood retention in intermittent and ephemeral streams in the Maltese Islands | *Alexander Galea* |
| | Pilot Project for Natural Water Retention Scheme (NWRS) in Burmarrad Catchment Basin, Malta | *Andrew Vella* |
| | Nature-based solutions in a semi-arid zone: The Sorek Stream basin in Israel | *Eran Ettinger* |
| ***10:30 - 10:45*** | *Coffee break* | |
| ***10:45-12:30*** | ***Public policity, spatial planning and stakeholders engagement: how to include and compensate flood retention services on private land?*** | |
| | Nature-based solutions in a semi-arid zone: Land-policy challenges | *Rachelle Alterman* |
| | Feasibility of Nature based solutions in the Italian urban context: the role of regional regulations | *Giovanna Grossi* |
| | Perception of stakeholders on the implementation of nature-based solutions for flood protection in Serbia, Bosnia, Slovenia and Iceland | *Aleksa Lipovac* |
| | Reflexions on Nature Based Solutions. Implementation in Portugal | *António Ferreira* |
| | Validating natural water retention measures in Portugal and Serbia in participative decision-making environment with hesitant analystic hierarchy process | *Bojan Srdjevic* |
| ***13:00 - 14:00*** | *Lunch (O Telheiro restaurant)* | |

## ANNEX II - LIST OF PARTICIPANTS

| Name | Surname | Country | Affiliation | Role |
|---|---|---|---|---|
| Alterman | Rachelle | Israel | Technion – Israel Institute of Technology | Researcher |
| Batista | Carlos | Portugal | Portuguese Environmental Agency, Water Resources Division | Stakeholder |
| Bonello | Stephen | Malta | Ministry for transport, infrastructure and capital projects | Stakeholder |
| Borg | Alexander | Malta | Ambient Malta, Office of the Director General, Ta' Qali Park, Ta' Qali | Stakeholder |
| Bravo | Nuno | Portugal | Portuguese Environmental Agency, Water Resources Division | Stakeholder |
| Damásio | Henrique | Portugal | Association of Irrigation and Beneficiaries of Lis Valley (ARBVLIS) | Stakeholder |
| Ettinger | Eran | Israel | Israel Ministry of Agriculture and Rural Development | Stakeholder |
| Ferreira | António | Portugal | Agrarian School of Coimbra | Researcher |
| Ferreira | Carla | Portugal | Agrarian School of Coimbra | Researcher |
| Gonçalves | José | Portugal | Agrarian School of Coimbra | Researcher |
| Grossi | Giovanna | Italy | National Association for research on urban drainage | Stakeholder |
| Lipovac | Aleksa | Serbia | University of Belgrade, Faculty of Agriculture | Researcher |
| Lobo-Ferreira | João | Portugal | National Laboratory of Civil Engineering | Researcher |
| Mourato | Sandra | Portugal | School of Technology and Management, Polytechnic Institute of Leiria | Researcher |
| Pardal | João | Portugal | Coimbra Municipality | Stakeholder |
| Pavesi | Filippo | Italy | Università Degli Studi Di Brescia | Researcher |
| Pezzagno | Michele | Italy | Università Degli Studi Di Brescia | Researcher |
| Russo | António | Portugal | Association of Beneficiaries of The Hydro-agricultural project of Baixo Mondego | Stakeholder |
| Salvati | Luca | Italy | Centro di Ricerca per lo Studio delle relazioni fra pianta e suolo | Researcher |
| Srdjevic | Bojan | Serbia | University of Novi Sad, Faculty of Agriculture | Researcher |
| Teiga | Pedro | Portugal | E.Rio - Engenho e Rio | Stakeholder |
| Veiga | Adélcia | Portugal | Agrarian School of Coimbra | Researcher |
| Vella | Andrew | Malta | Ministry for transport, infrastructure and capital projects | Stakeholder |

*“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.”*

*Margaret Mead*

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