Quick scan natural water retention measures for tributaries of Rio Tajo near Toledo

Wetlands International

CIREF Centro Ibérico de Restauración Fluvial

stroming

Bureau Stroming
November 2023

1. Introduction

Heavy rains poured down in the afternoon and evening of September 3th 2023 in central Spain. A slow-moving storm system (DANA) passed by, officially known as an upper-level isolated depression. The high intensity of the rainfall in combination with total precipitation rates exceeding 100 mm caused huge floods in the Madrid and Toledo region.

With (sea) temperatures rising due to climate change, rainfall patterns are changing all across Europe and this type of severe rainfall events are predicted to happen more often.

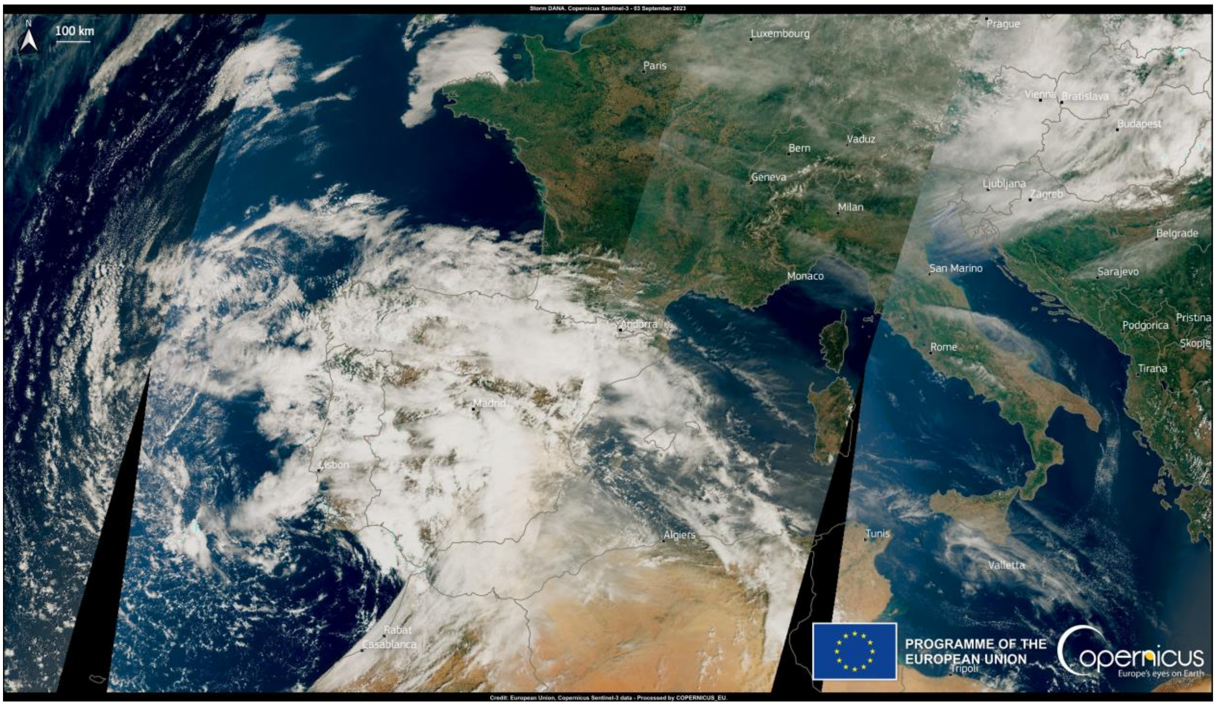


Figure 1: Storm DANA seen from Copernicus Satellite on September 4th 2023

In this desktop study the an overview will be given of the present situation, the rainfall event and the potential of Nature Based Solutions to delay the flow of water in tributaries of the river Tajo near Toledo.

The quick scan will focus on four tributaries of the river Tajo near Toledo: 1. Arroyo del Aserradero, 2. Arroyo de la Degollada, 3. Arroyo del la Rosa and 4. Arroyo de Ramabujas.

The study and analyses are included on the interactive site:
https://media.stroming.nl/toledo/#

2. Rain event DANA september 3th 2023

By analysing weather station network https://www.wunderground.com/ a precipitation pattern on September 3th in the Toledo region could be distinguished. The most reliable network stations are showed in the graphs below. Total precipitation rates increased from 75 mm in Cobisa (south) to almost 100 mm in El Beato (north). The rainfall followed roughly the same pattern with rainfall intensity around 40 mm / hour during the afternoon and extreme high rainfall intensity (74 – 134 mm / hour) between 20:00 and 21:00 in the evening.

Rainfall intensity is an important factor for flood risk. Depending on soil conditions and land use, overland flow occurs when intensity of rainfall increases.

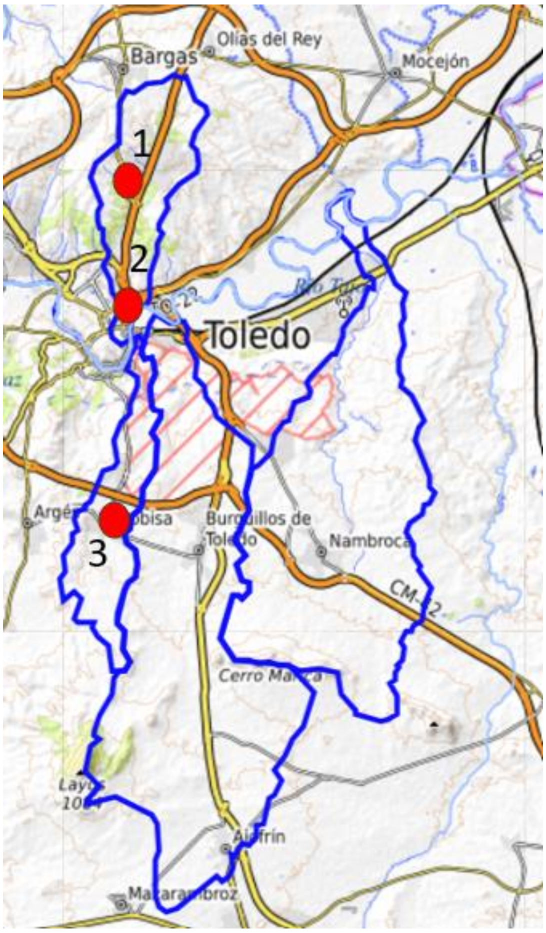
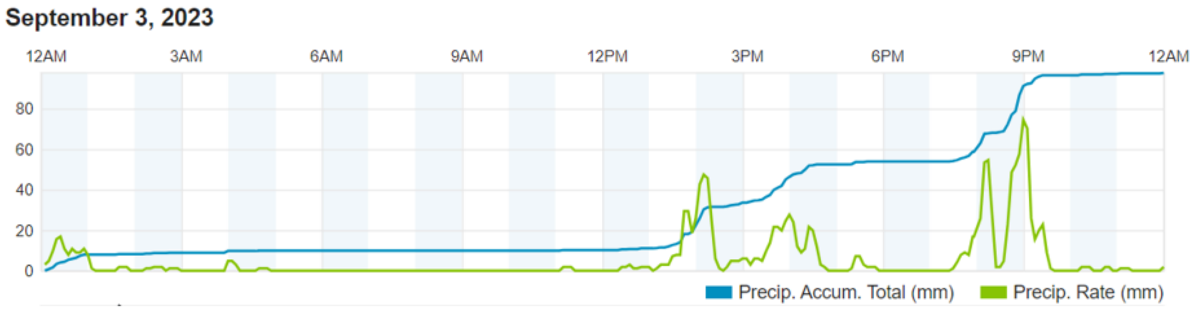
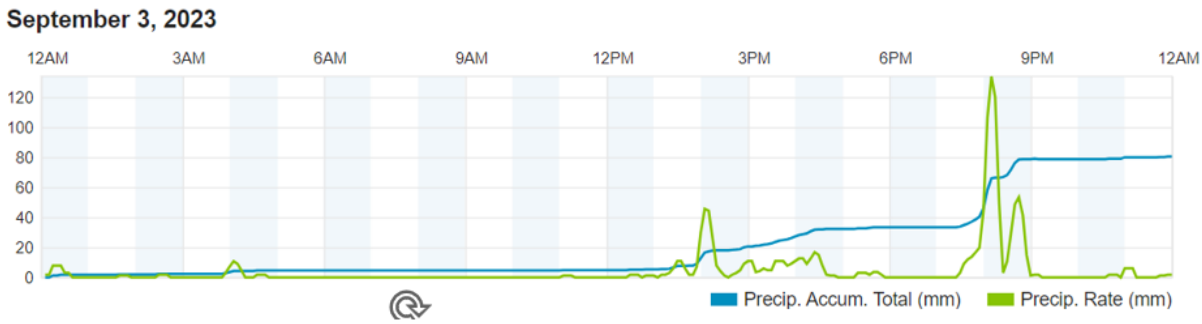


Figure 2: Catchments of the Tajo tributaries Arroyo del Aserradero, Arroyo de la Degollada, Arroyo del la Rosa and Arroyo de Ramabujas and the location of the private weather stations that are connected to Wunderground.

Arroyo del Aserradero, El Beato
Total Precipitation: 97 mm
Highest precipitation rate: 74 mm / hour



Arroyo del Aserradero, Toledo
Total Precipitation: 80 mm
Highest precipitation rate: 134 mm / hour



Arroyo de la Degollada, Cobisa
Total Precipitation: 75 mm
Highest precipitation rate: 82 mm / hour

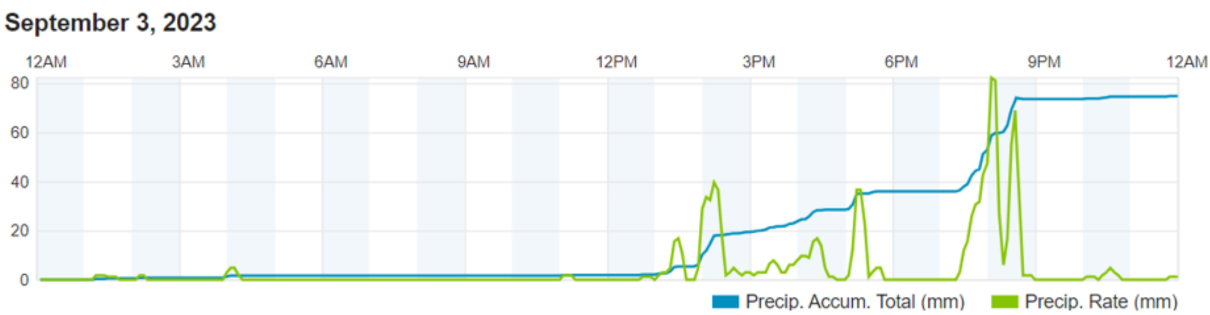


Figure 3: Precipitation graphs for 3 private weather stations in the Toledo region. The blue line show the accumulated precipitation (mm) and the green line shows the precipitation rates (mm / hour)

3. Potential natural water retention measures

In this chapter the most important topics regarding flood risk in these catchments will be highlighted and inventoried by the potential for natural water retention measures.
An effective NWRM delays the water discharge as can be seen in the figure below.

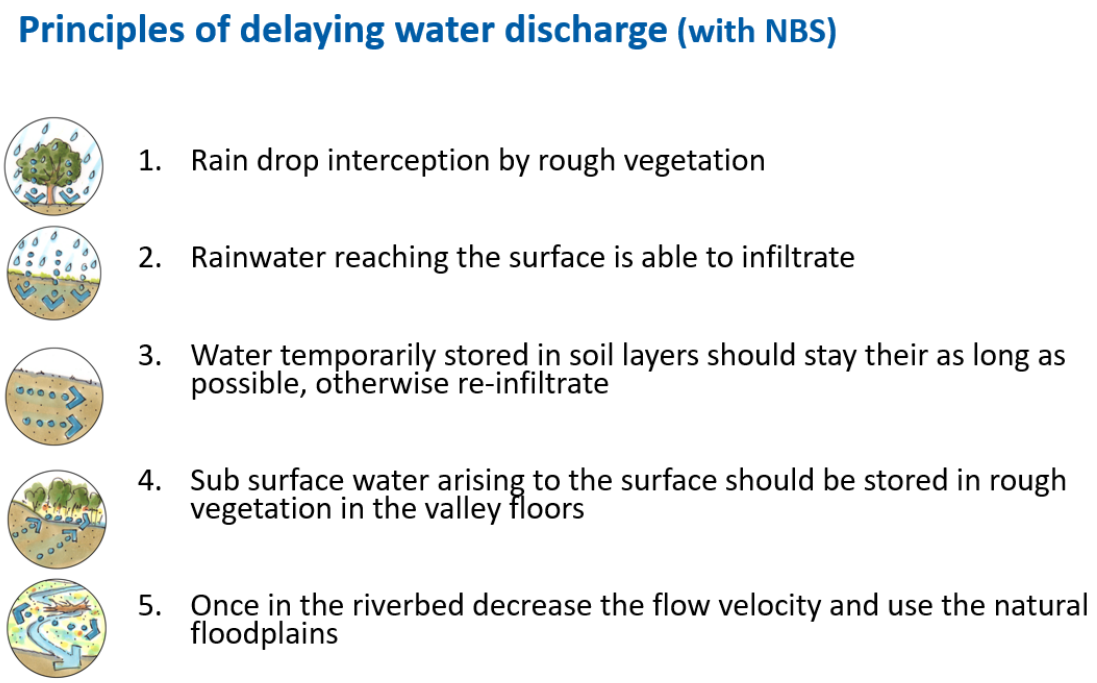


Figure 4: By following the raindrop on its journey to the river one can determine the best measures to delay the discharge of water with nature based solutions.

3.1 Potential area for natural sponges

With a GIS analyses the low lying areas with a low slope percentage (<10%) are determined. These areas are potentially available for natural water retention measures.

- Arroyo del Aserradero: The available space for NWRM is mainly occupied by urban settlements and the highway A-42 to Toledo. The challenge in this catchment is to retain water discharging from roads and paved surfaces.
- Arroyo de la Degollada: A large percentage of the suitable area is unbuild with the village of Cobisa as exception. There are many chances for NBS to retain water.
- Arroyo de la Rosa: A large percentage of the suitable area is unbuild and has enough space for NWRM, with the downstream urban settlement of Santa Barbara as exception. There are many chances for NBS to retain water.
- Arroyo de Ramabujas: A large percentage of the suitable area is unbuild and has enough space for NWRM, with the downstream urban settlement of Santa Maria as exception. There are many chances for NBS to retain water.

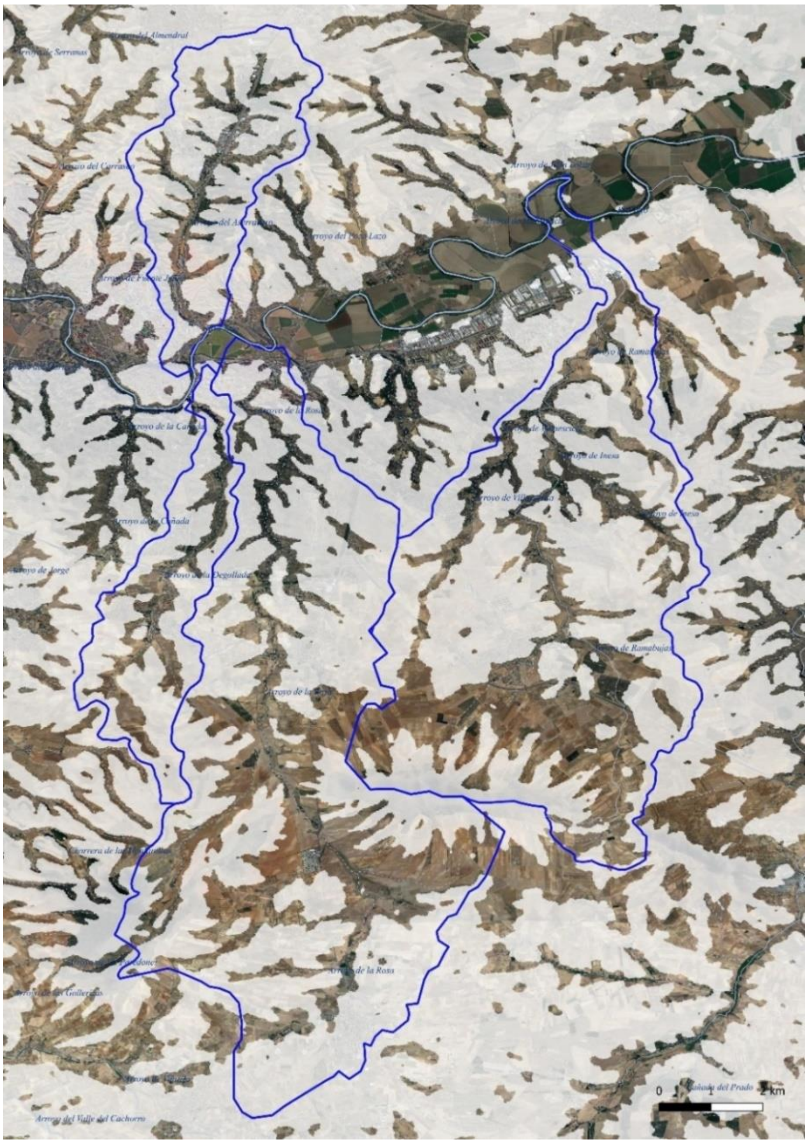


Figure 5: GIS analyses to determine low lying areas with a low slope gradient within the catchments. These are the areas potentially suitable for Natural Water Retention Measures. https://media.stroming.nl/toledo/#

3.2 Urban development

Runoff from paved surfaces contribute significantly to peak flows in case of a DANA type rain event. By creating sponge cities and wadies, water discharge can temporally be stored and delayed, preventing it to be part of the flooding downstream.

Figure 6: Shopping centre (13 ha) next to the Arroyo del Aserradero. The DANA event with almost 100 mm rainfall caused a runoff potential of 13.000 m3 water from this shopping centre only.

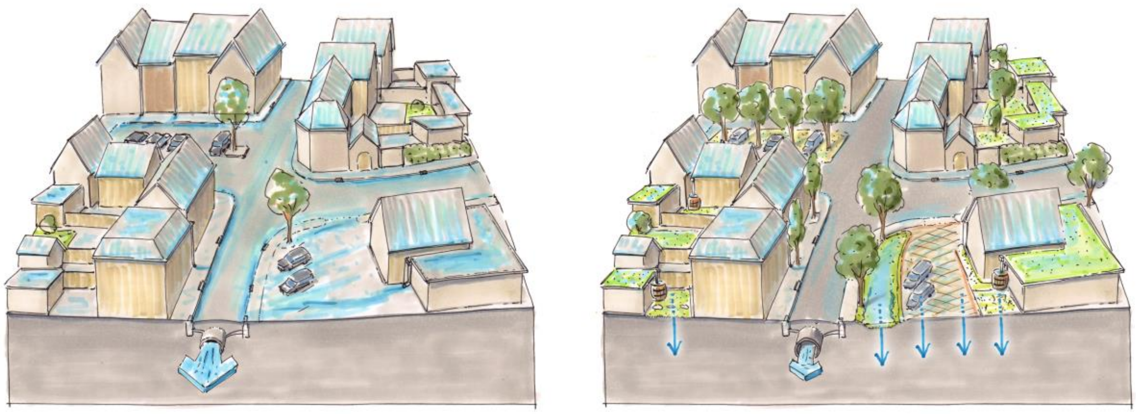


Figure 7: The development of sponge cities contribute to minimalize the discharge from paved surfaces.

3.3 Spatial planning

In the past decades villages, often situated next to streams, expanded their territory.
The 1953 aerial photograph shows that the village of Cobisa was situated next to the Arroyo de la Degollada. In the current situation the new urban layout is situated on top of the stream. The expansion continues as new houses are being build north of the village on the course of the Arroyo de la Degollada.

Figure 8: The expansion of the Cobisa in the past decades on top of the stream (upper picture). The expansion continues as new houses are being built on the course of the Arroyo de la Degollada (lower picture left). Water filled with sediments flowed through the village of Cobisa on the September 3th 2023 (lower picture right).

The Arroyo de la Rosa and Arroyo de Ramabujas are both forced in a small channels in the downstream villages of Sante Barbara and Santa Maria, leaving little space for processing high peak discharges.

Figure 9: Arroyo de la Rosa goes underground in the village of Santa Barbara (left), Arroyo de Ramabujas is channelled while passing the village of Santa Maria.

The village Burguillos de Toledo situated next to the Arroyo de la Rosa expanded as well in the past decades. The stream though was respected and is still largely without buildings on its side. For flood resilience it's important to protect natural valleys.

Figure 10: Spatial development of the village Burguillos de Toledo between 1956 and 2023. The Arroyo de la Rosa largely kept its valley despite the expansion of the village.

Figure 11: Protected natural valleys are prerequisite for flood resilience.

3.4 Water discharge from roads

Roads on slopes act like extended river channels in case of DANA type rain event. They attract water from the surrounding areas, increase the flow velocity and discharge the collected water direct to the stream. Interception of the discharge from roads in wadies or guide it through natural vegetation can temporally store and delay the discharge of water.

Figure 12: Next to the Arroyo de Aserradero lies the Autovida de Toledo. The autovida acts like an extended stream in case of a DANA type event.

Afstroom van wegen bufferen in natuurlijk grasland (foto Hettie Meertens)

Figure 13: Disconnecting roads from rivers. Water can temporarily be stored in wadies or flow slowly through natural vegetation.

3.5 Rural land use

In central Spain rural areas transform in bare desolated fields after crop harvesting in early summer. In olive fields soils remain largely uncovered year-round, they lack often the undergrowth of grasses and herbs. Due to changes in texture, bare soils have less capacity for water infiltration than soils covered with a closed vegetation. The soils are vulnerable to erosion and surface run-off and therefore contribute to peak discharges in the case of a DANA type rain event.

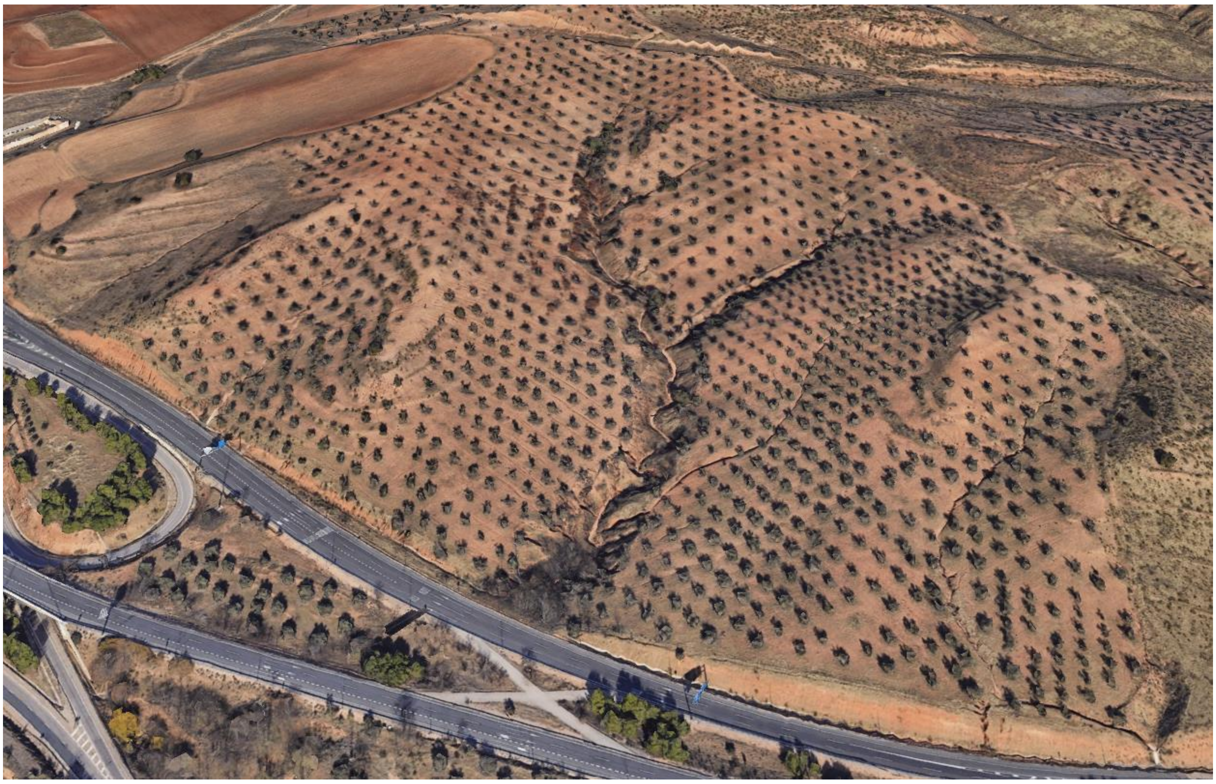


Figure 14: Gullies formed by erosion in an olive field in the Arroyo del Aserradero

Figure 15: Bare soils surrounding the village of Cobisa.

Figure 16: After the DANA event Cobisa was covered with thick layers of mud coming from surrounding bare fields.

The transition from bare fields to natural grassland with herb and trees increases the absorption capacity of the soil, protects the fertility of the soil and increases biodiversity.

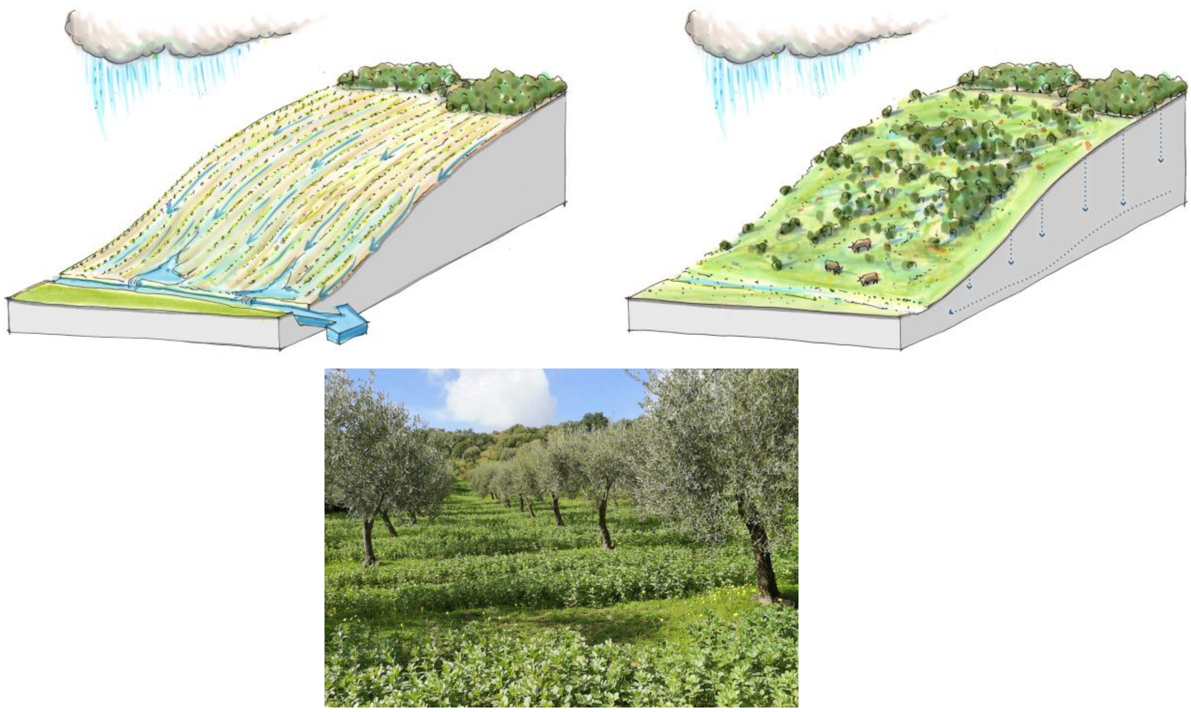


Figure 17: The transition of land use from bare fields to natural grassland is an effective NBS measure for flood resilience. The use of grasses and herbs as undergrowth between the olive trees protect the fertile soil and increases the soils infiltration capacity and biodiversity.

3.6 Natural sponges in natural valleys

In the three southern catchments enough space is available for the development and preservation of natural sponges. Downstream peak discharges can be reduced by retaining water in natural sponge valleys in the upstream areas. In the natural sponge valleys drainage and extended river segments are removed and natural valley plains can be flooded. There are some beautiful examples of natural sponge valleys in the three southern catchments which can be used as a showcase to transform other parts of the catchments into natural sponge valleys.

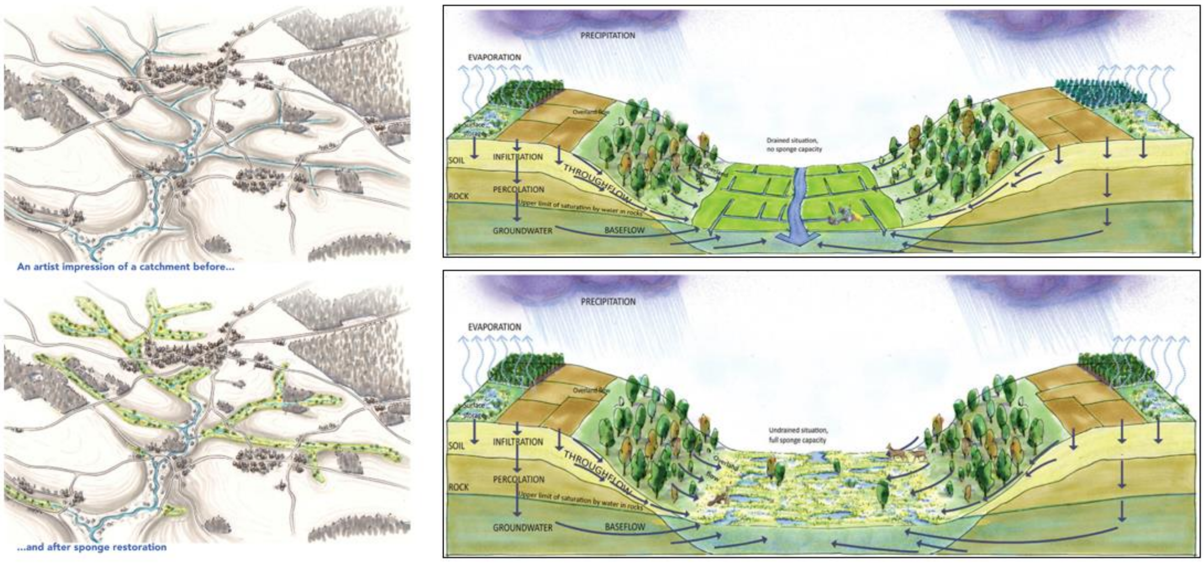


Figure 18: The transition of land use from bare fields to natural grassland is an effective NBS measure for flood resilience. The use of grasses and herbs as undergrowth between the olive trees protect the fertile soil and increases the infiltration capacity and biodiversity.

Figure 19: Beautiful example of a natural sponge valley in Arroyo del la Rosa. The natural vegetation delays the discharge of water. It therefore helps to reduce peak flows and delay the incoming drought.

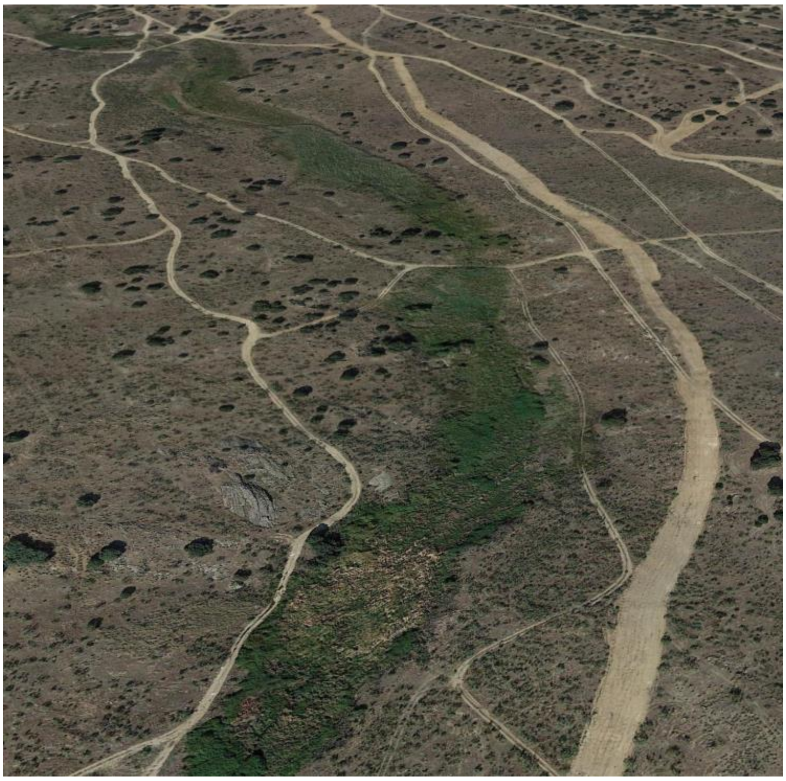


Figure 20: Natural sponge valley in Arroyo de la Degollada. The natural vegetation delays the discharge of water. It therefore helps to reduce peak flows and delay the incoming drought. There may be change

Figure 21: Natural sponge valley in Arroyo de Ramabujas. The natural vegetation delays the discharge of water. It therefore helps to reduce peak flows and delay the incoming drought.

4. Conclusions

There are many chances for nature based flood resilience measures in the four analysed catchments. The measures vary from green villages, intercepting water from roads and spatial planning to land use changes and the development of natural sponge valleys.
On the interactive website, https://media.stroming.nl/toledo/#, one can travel through the catchments history, present situation and hopefully a green, flood resilient future.

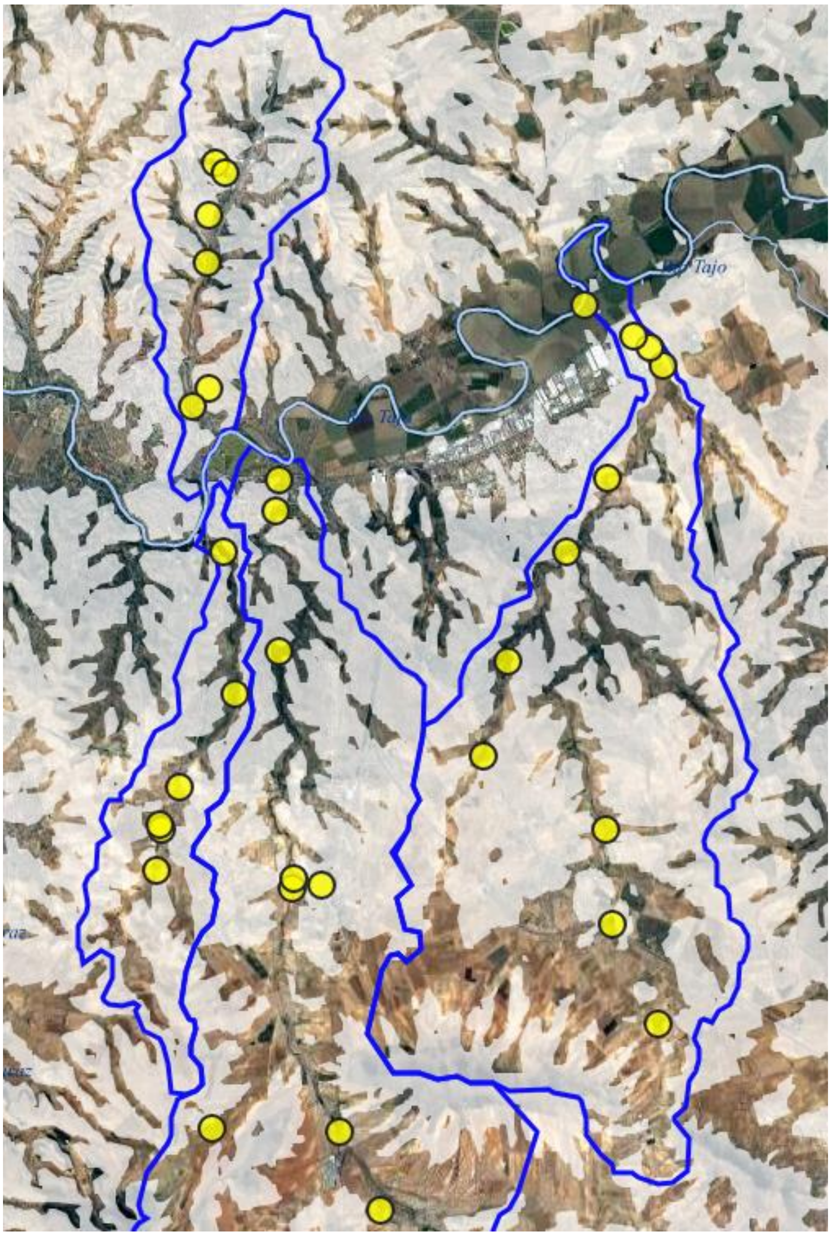


Figure 22: Interactive map of the valley floors where one can travel through the catchment by clicking on the yellow dots: https://media.stroming.nl/toledo/#