cef Centro de Estudos Florestais 40 years

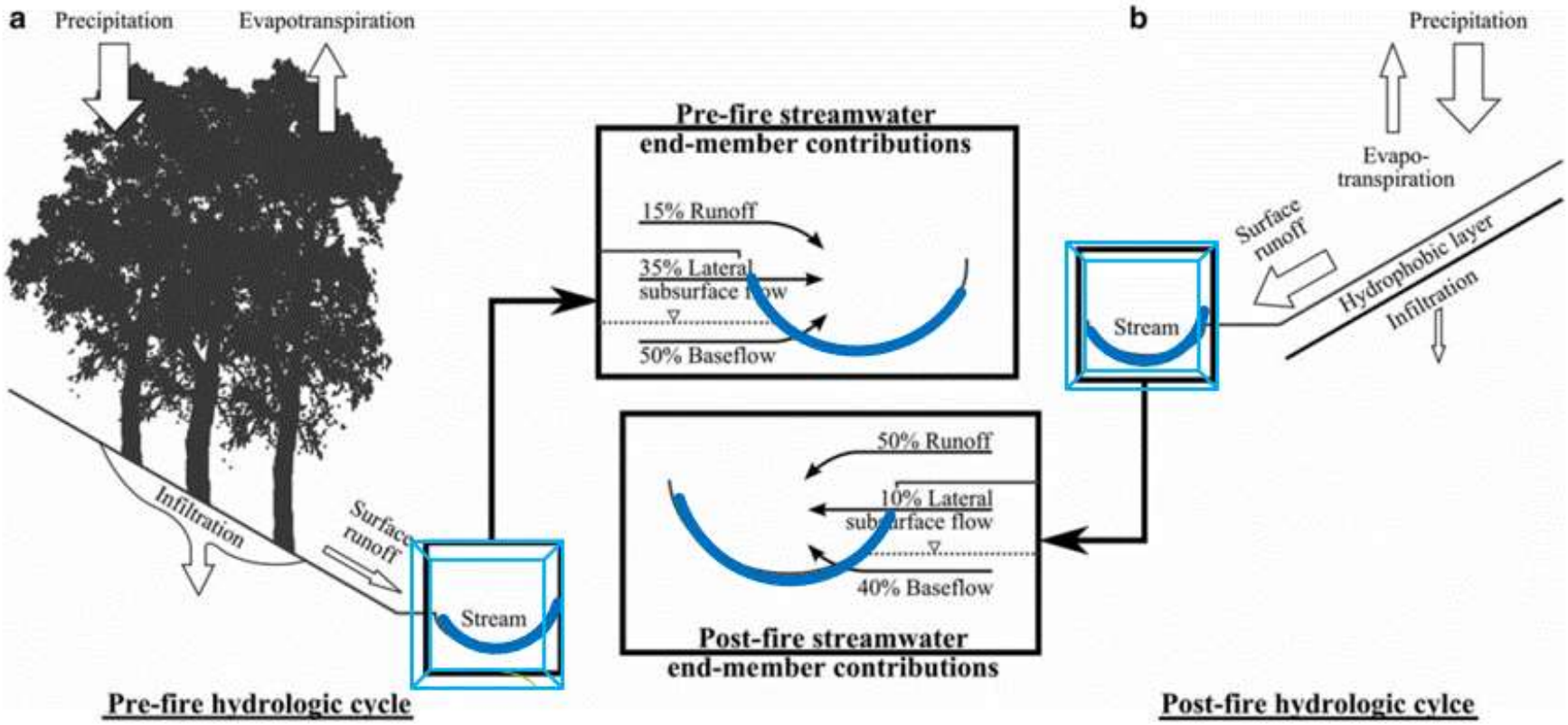
Session: New challenges for forest research

FIRE AND PEAK FLOWS IN AFFORESTED CATCHMENTS: WE NEED TO ACT!

UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO utad

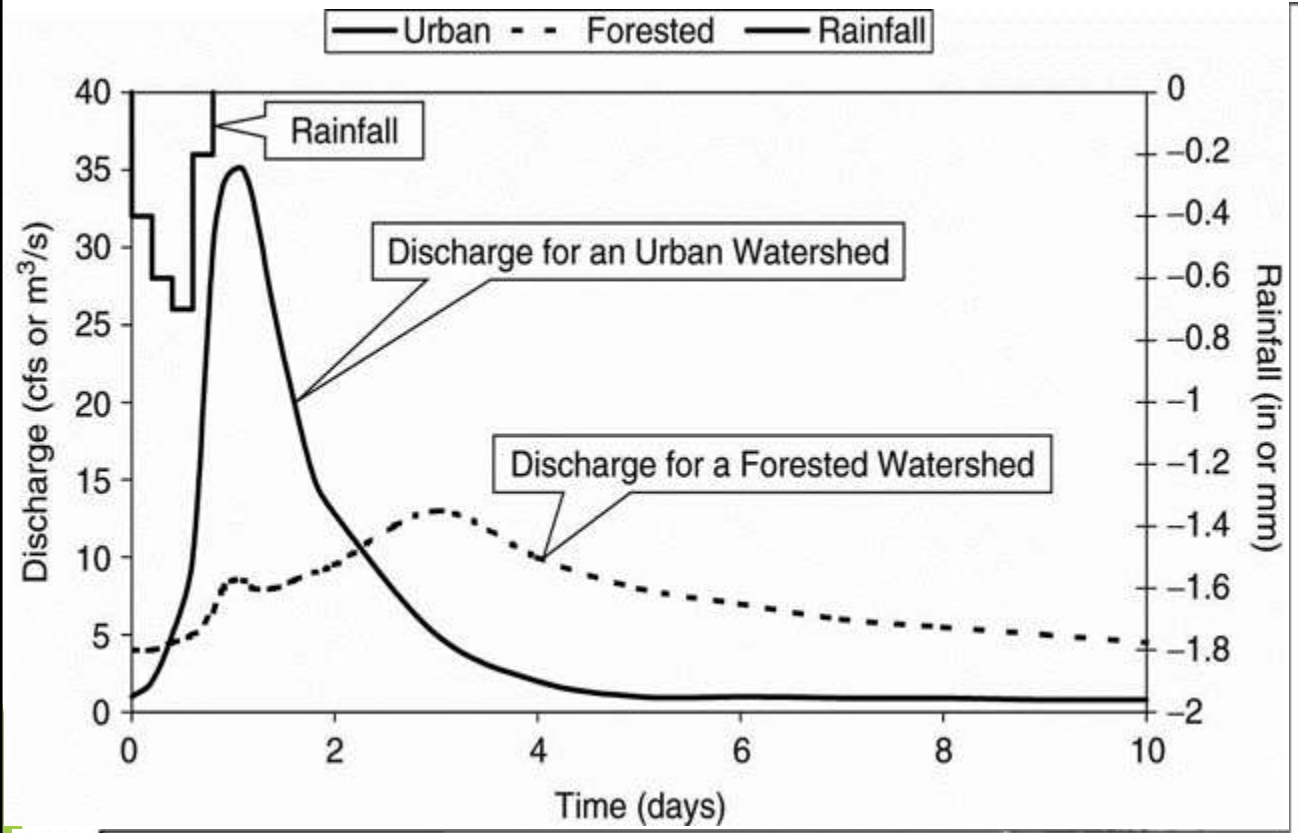
Rui M.V. Cortes

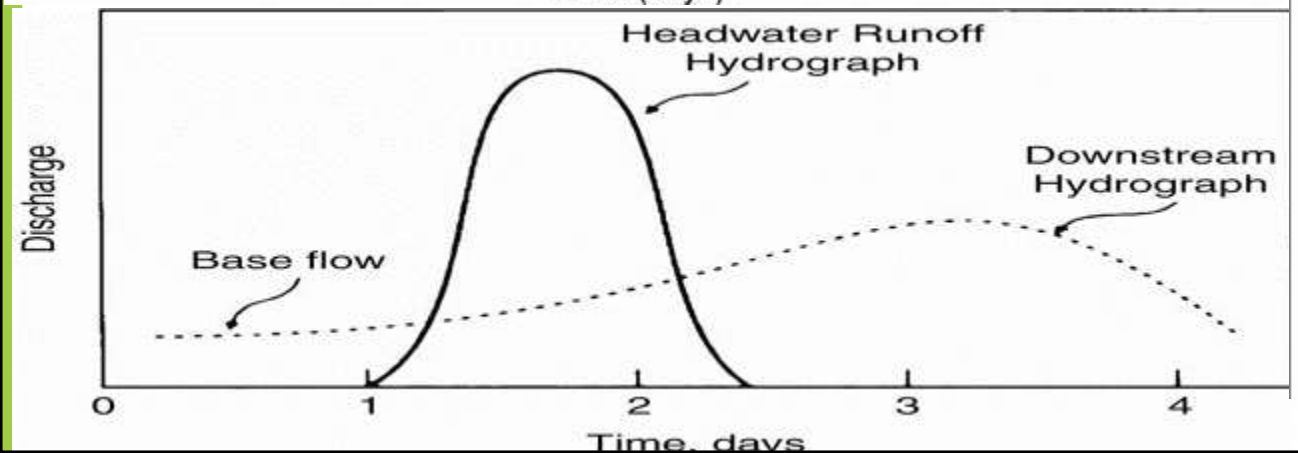
Impacts of fire on hydrologic cycling and streamwater within forested hillslopes

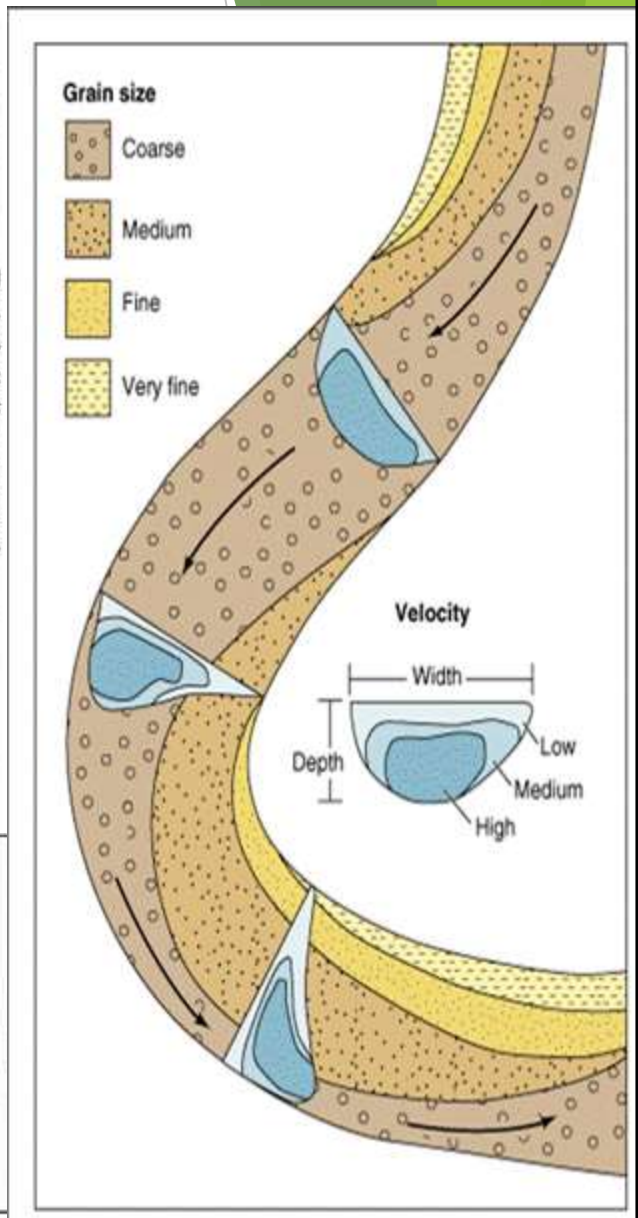


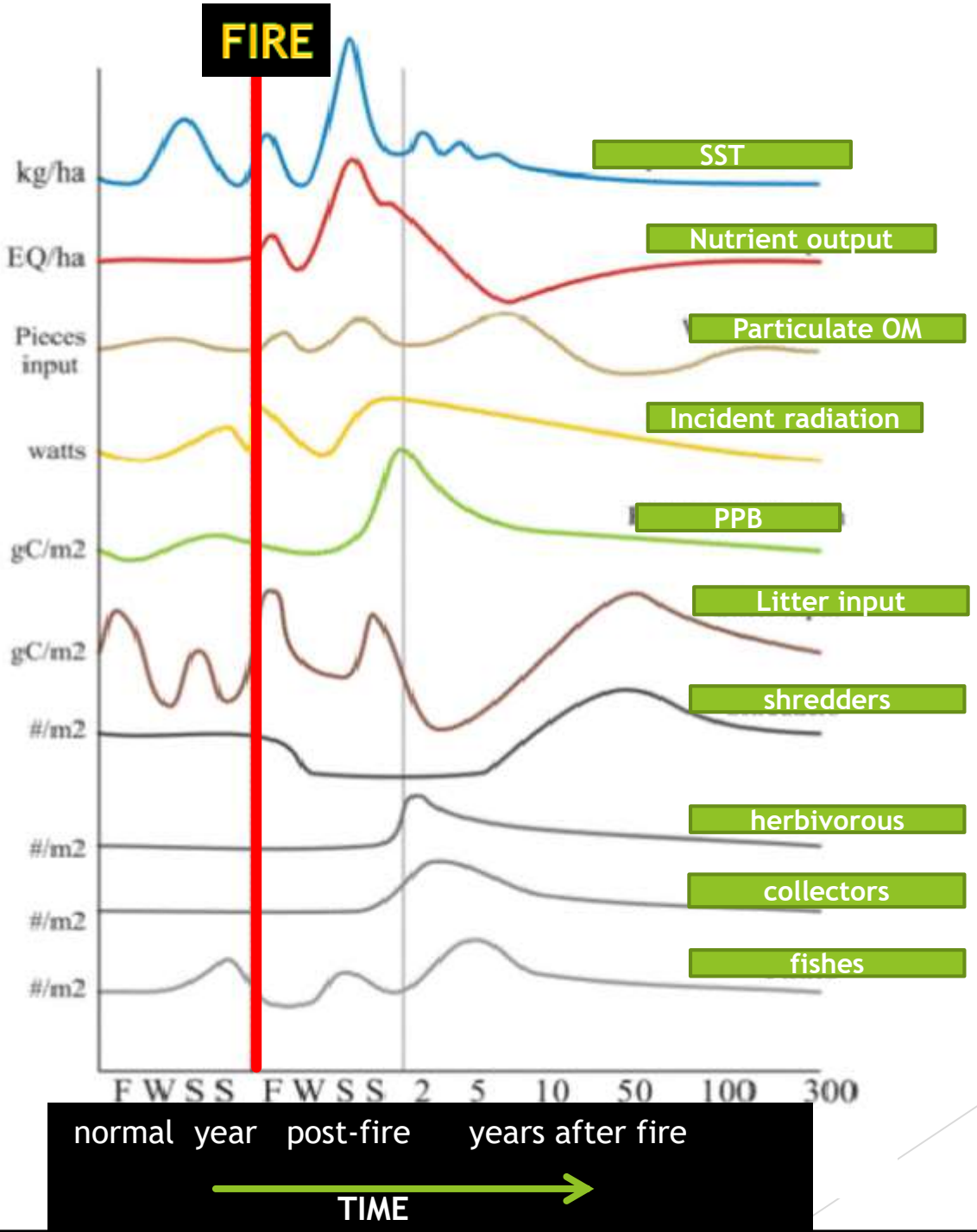
Onodera & Stan, 2011

Impacts of fire on peak flows related to soil impermeability



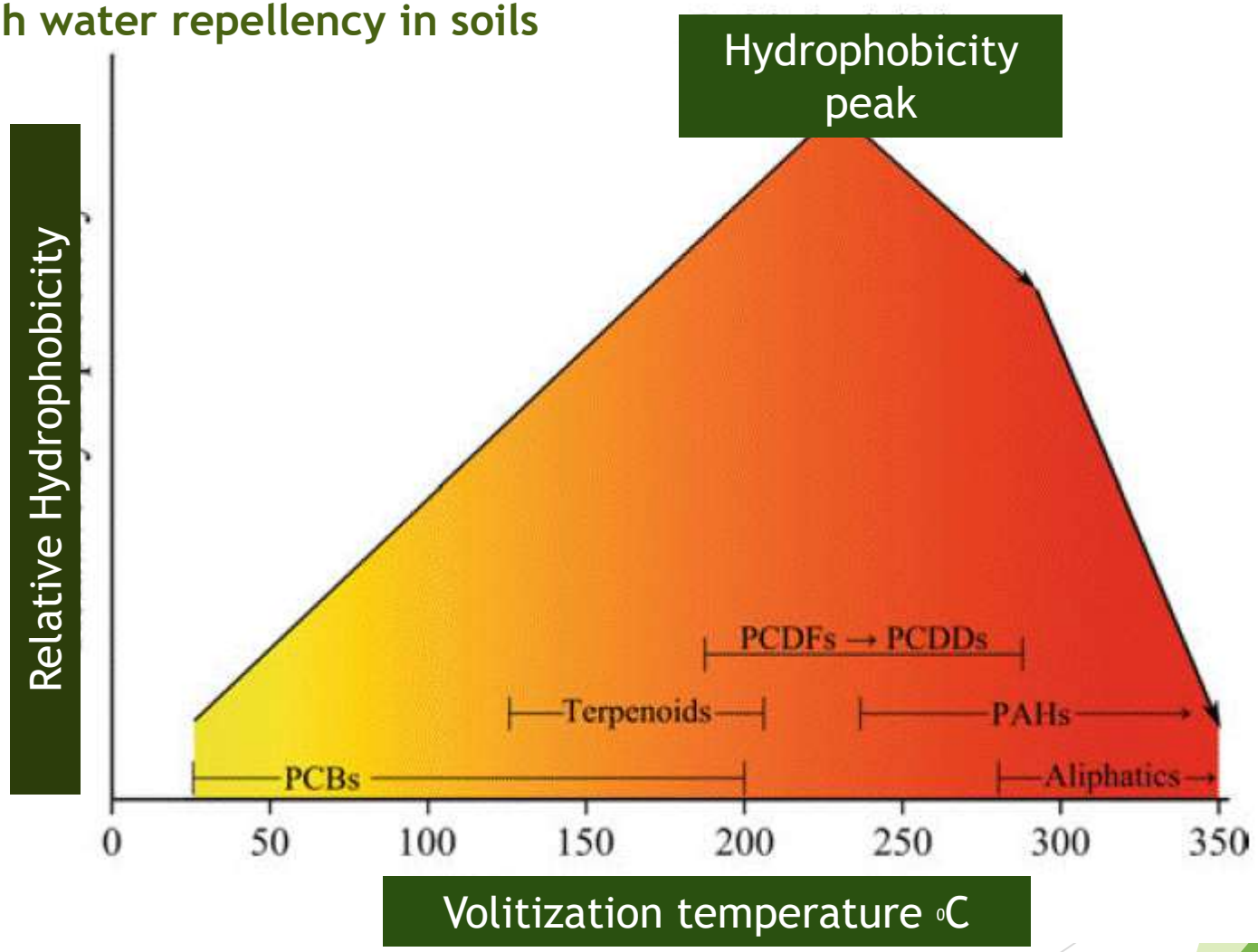






But after fire the aquatic ecosystem reflects changes for a long period …

Fire-related soil temperature increases cause the volatization of various organic compounds that can enhance or diminish water repellency in soils

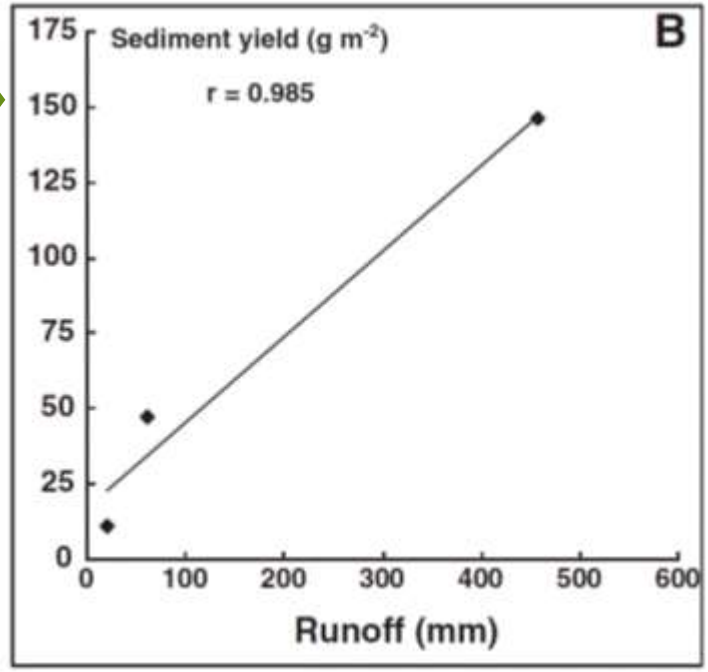


Onodera & Stan, 2011

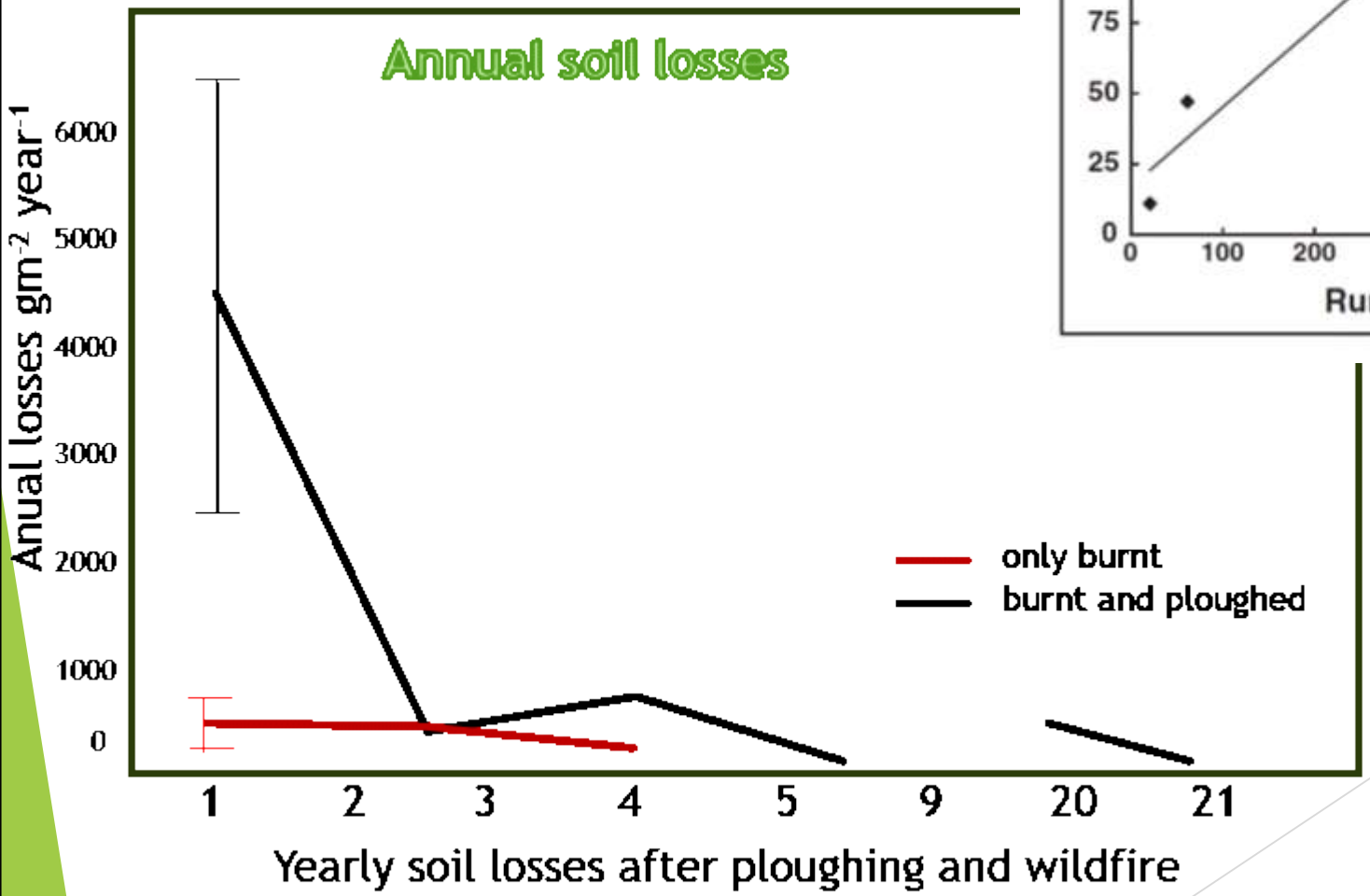
Impacts of fire on peak flows in pine stands (*Pinus ponderosa*)

Kenneth N. Brooks, e t. al., 2012

soil losses (when repellency is high) in post-fire situations are directly related to direct runoff



Díaz-Raviña, et al., 2012.



(compilation from several studies by Prats et al, 2014)

agradation

So, after fire stream channels are modified and flood comes…

degradation

...and downstream areas, with dramatic losses

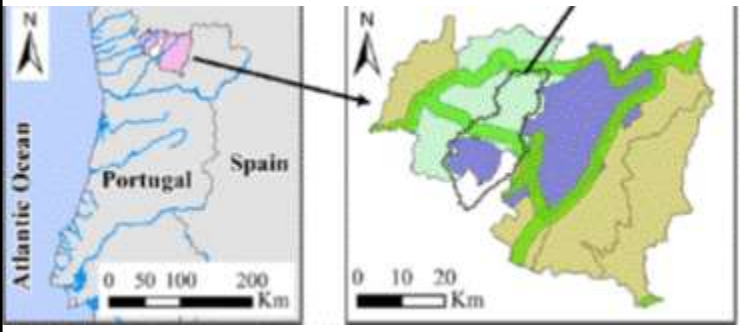
Science of the Total Environment

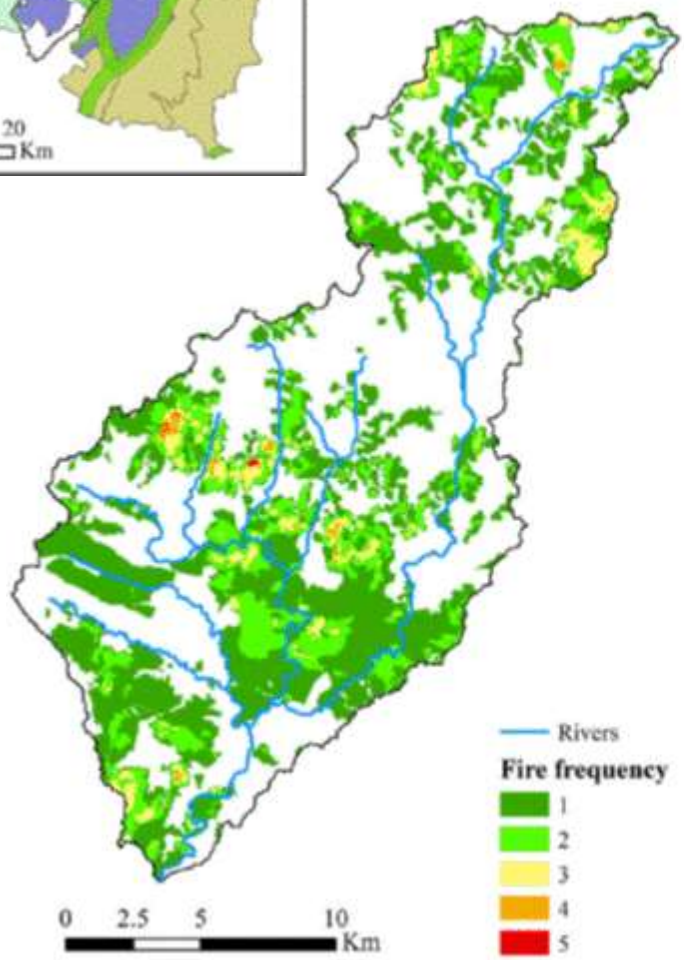
journal homepage: www.elsevier.com/locate/scitotenv

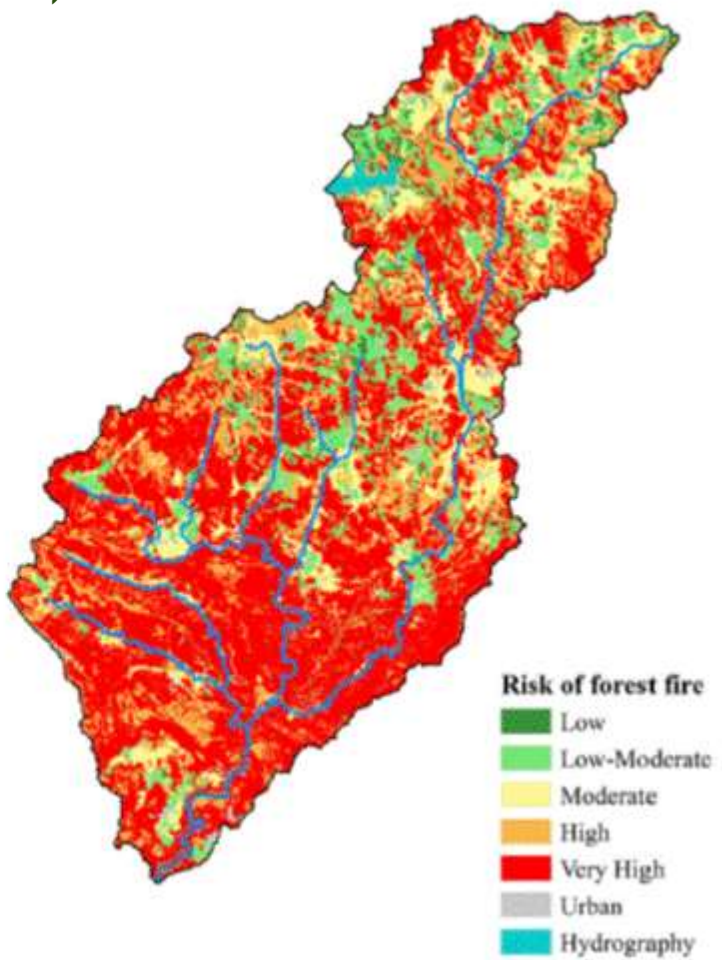
Water resources planning for a river basin with recurrent wildfires

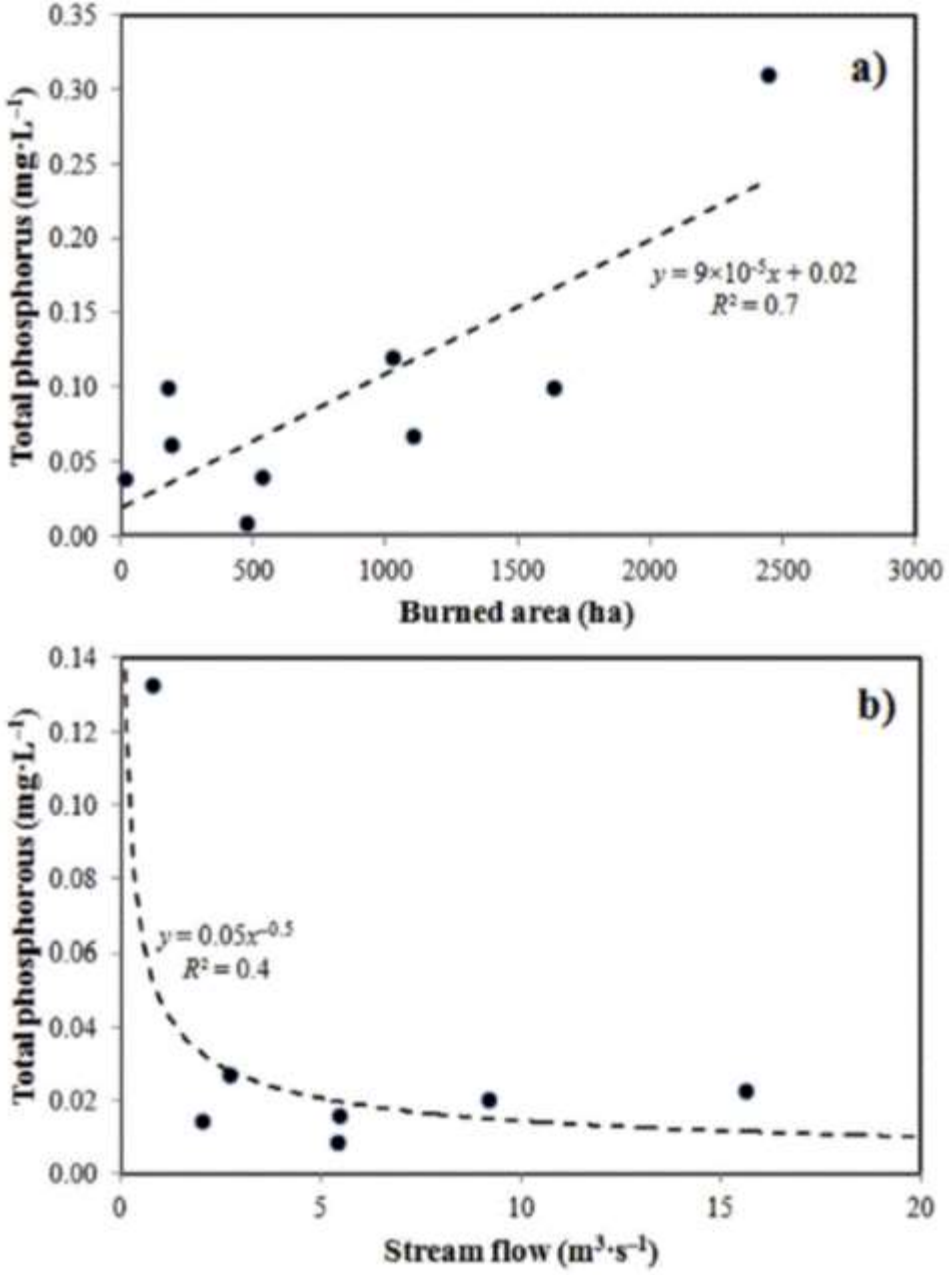
R.M.B. Santos [a], L.F. Sanches Fernandes [a,d], M.G. Pereira [a,b,e], R.M.V. Cortes [a,f], F.A.L. Pacheco [c,g,*]

FIRE AND STREAM EUTROPHICATION (R.BEÇA, LIMA CATCHMENT)



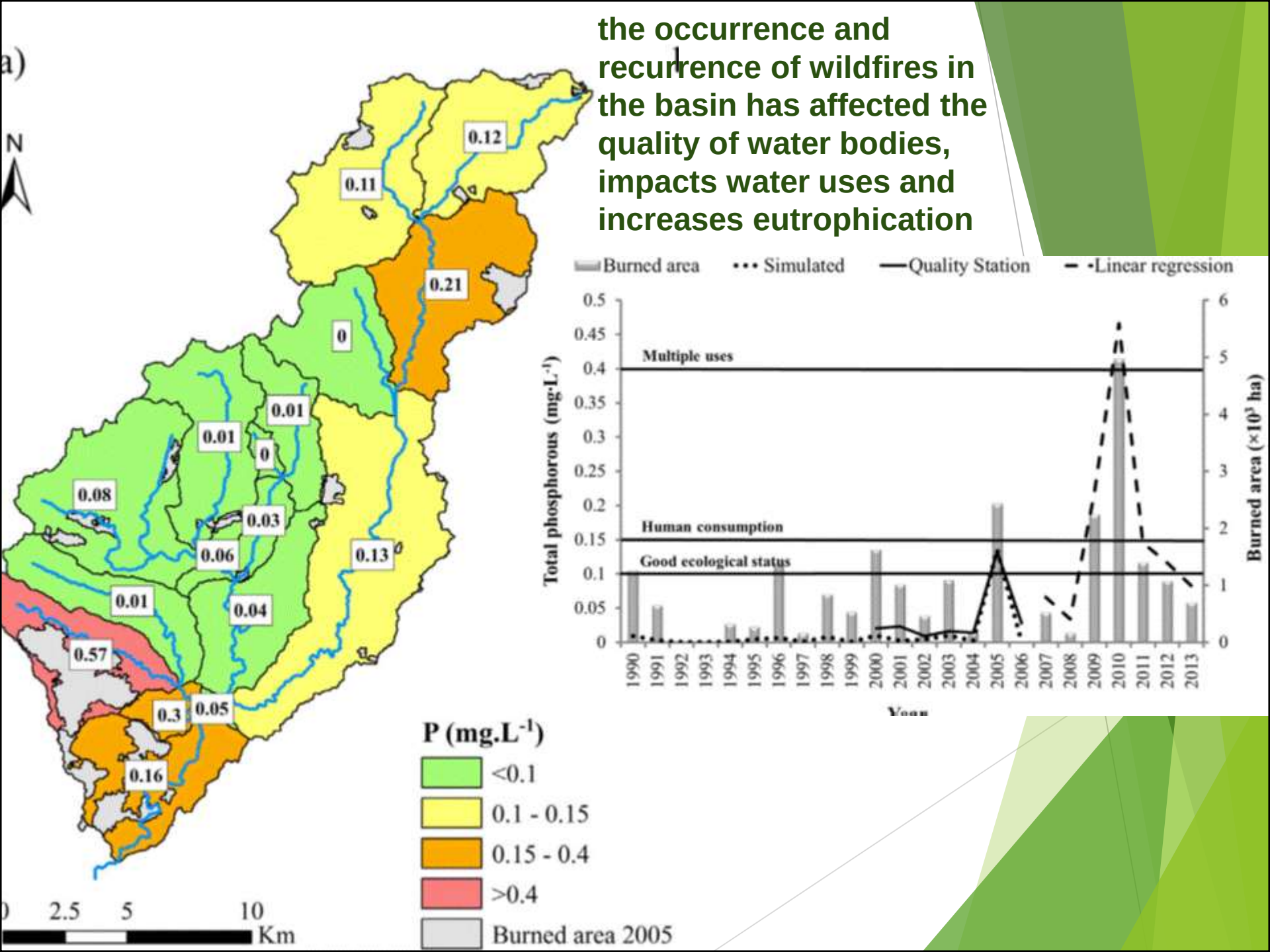






maximum phosphorus concentration, flow and burned area, period 2000-2008

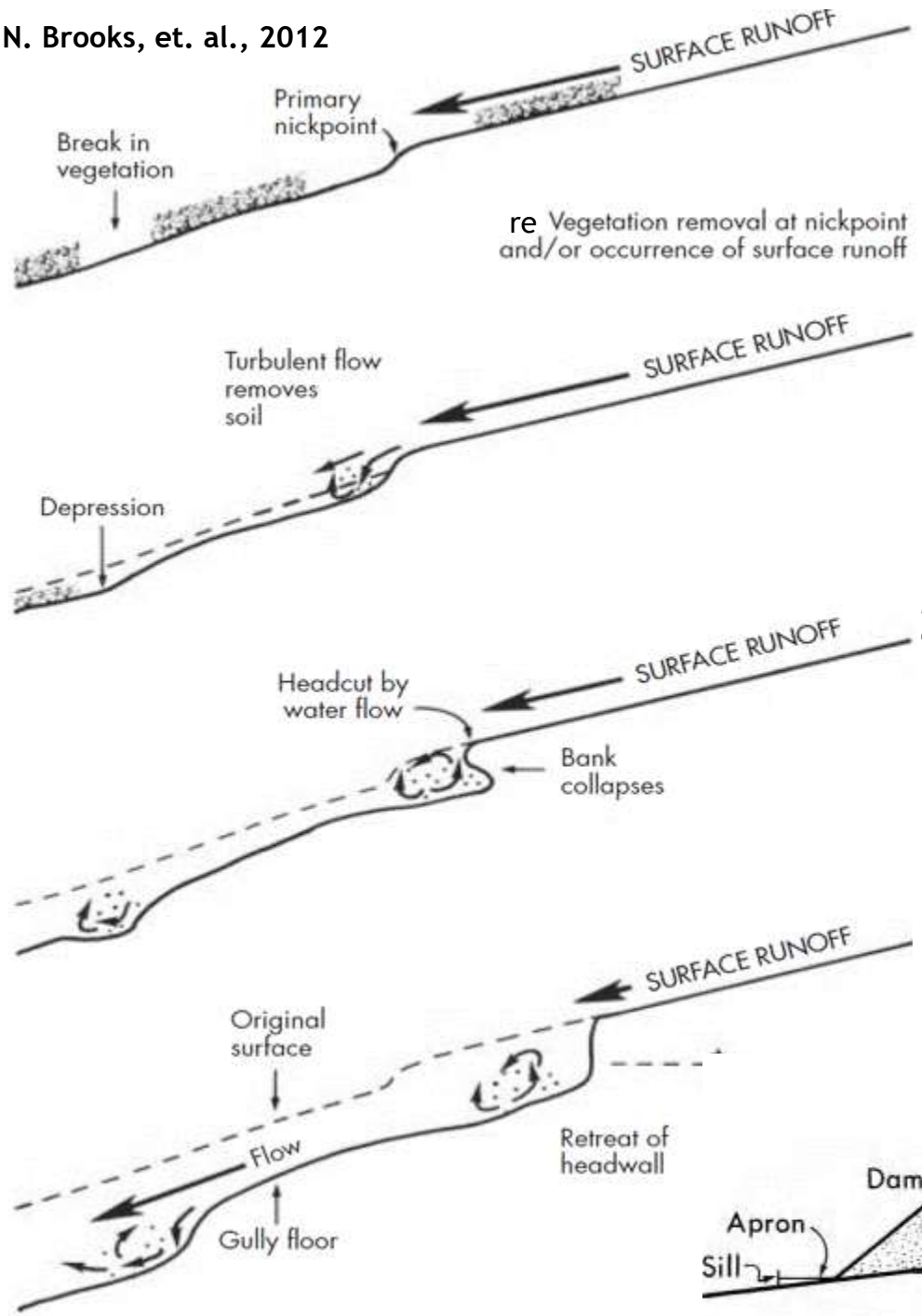
the occurrence and recurrence of wildfires in the basin has affected the quality of water bodies, impacts water uses and increases eutrophication

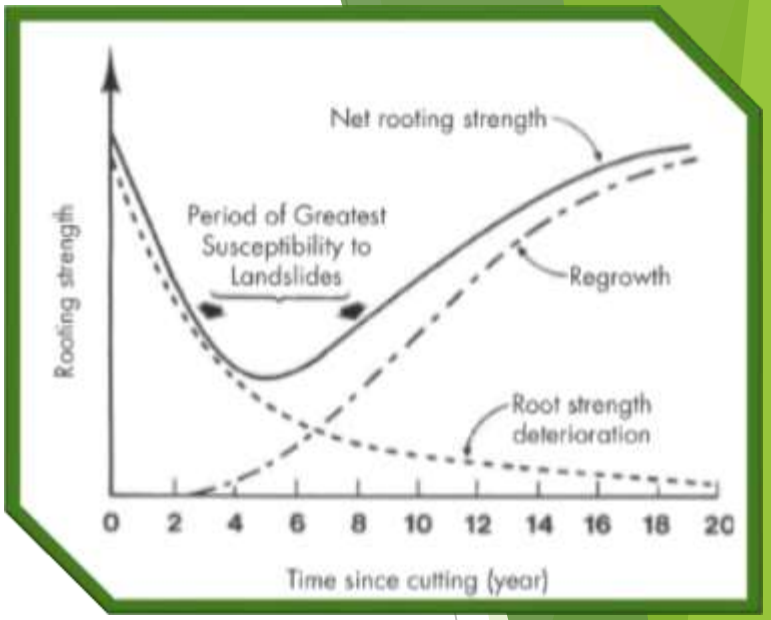


Simple (?) management rules

- Maximize distance between run-off flux and running waters.
- Increase infiltration rate (cover or structural protection)
- Maximize concentration time (reduction direct flow velocity)
- Minimize total flow rate per unit of ploughed area
- Use buffer strips (forest layers or wetlands)
- Divert waters into specific areas (especially from urban areas or unstable slopes)
- Decrease peak flows: structural or non-structural approaches?
- Immediate action towards special measures after fire events to avoid high sediment loads

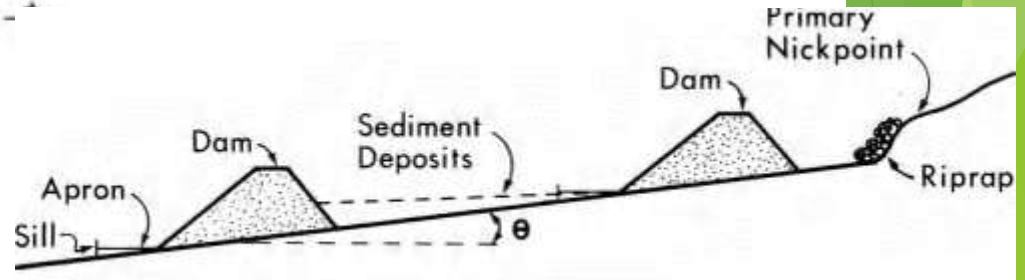
neth N. Brooks, et. al., 2012

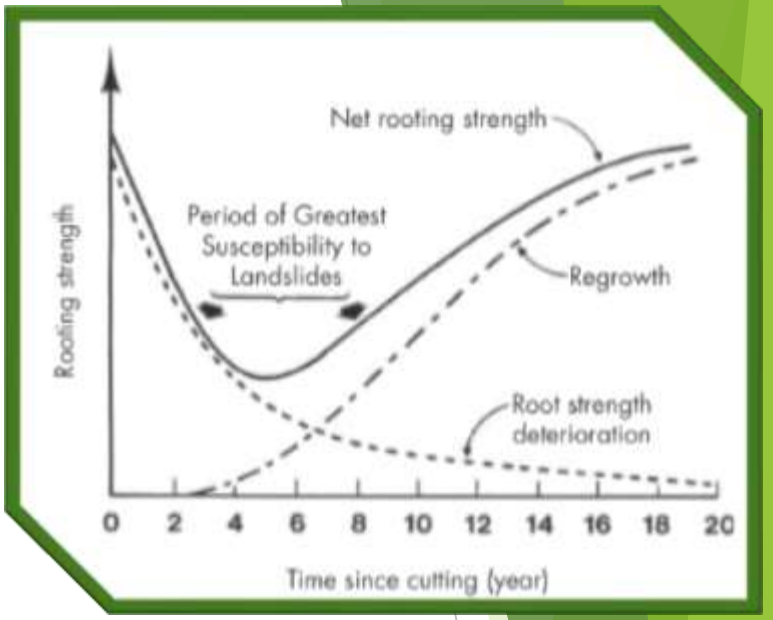




MAXIMIZE CONCENTRATION TIME (REDUCTION DIRECT FLOW VELOCITY

gully development after fire and check dams to stabilize a gully channel temporarily to allow vegetation to become established





MAXIMIZE CONCENTRATION TIME (REDUCTION DIRECT FLOW VELOCITY

gully development after fire and check dams to stabilize a gully channel temporarily to allow vegetation to become established

REDUCTION
DIRECT
FLOW
VELOCITY

trapping
sand-sized
sediments

Log erosion barriers (LEBs)

Sediment trapping methods

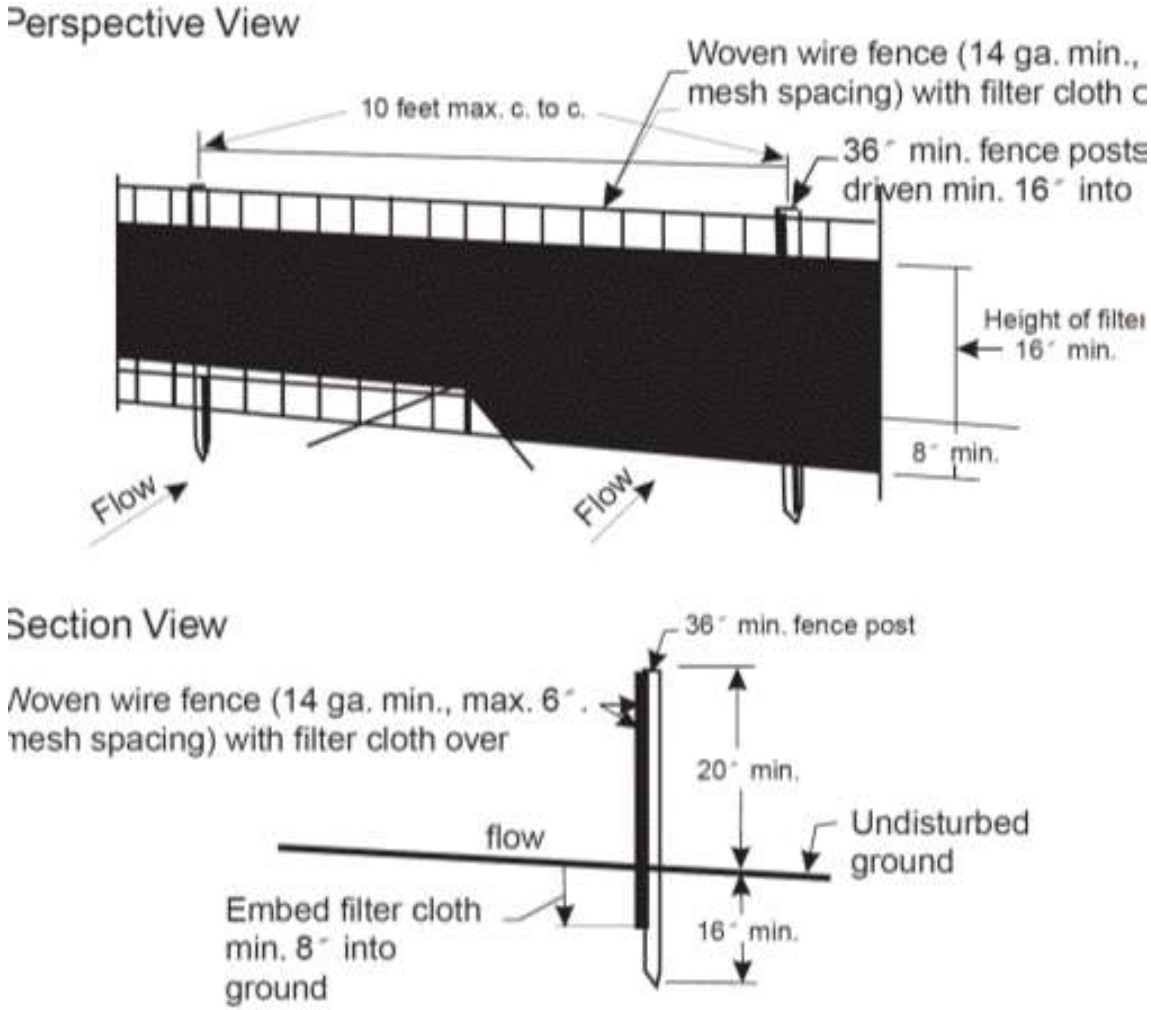
A Log Debris Dam (LDD) made of horizontally stacked pine logs

LDD and sedimentation pond

LDD made by intertwining branches together across a stream channel.

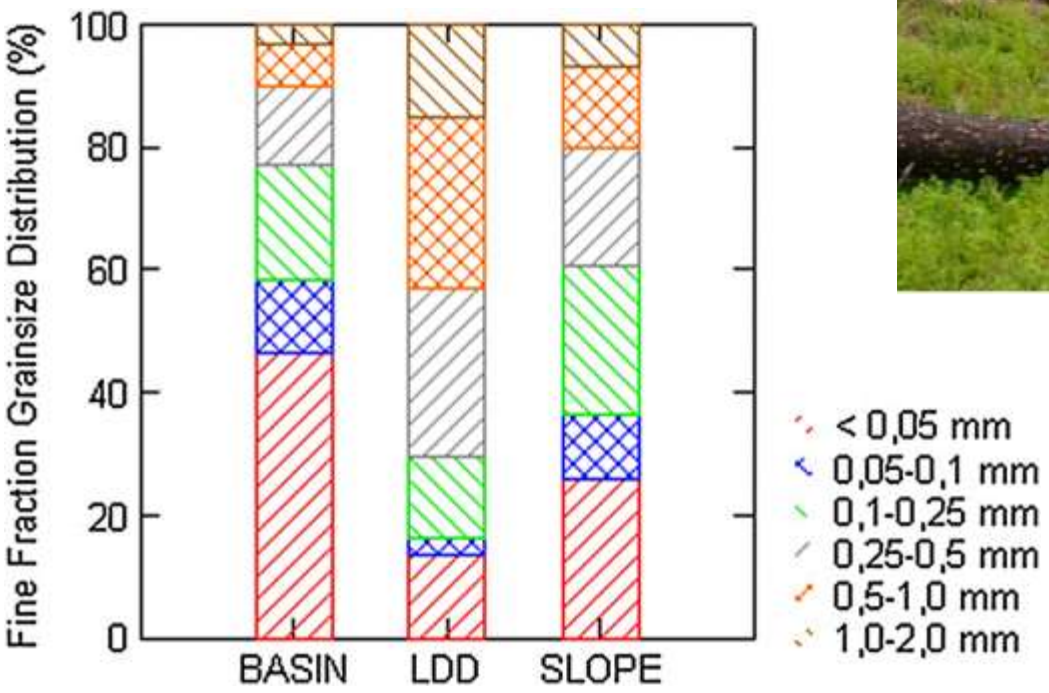
From, Fox, 2011

Sediment trapping with wire fences



Colorado State University Report, 2015

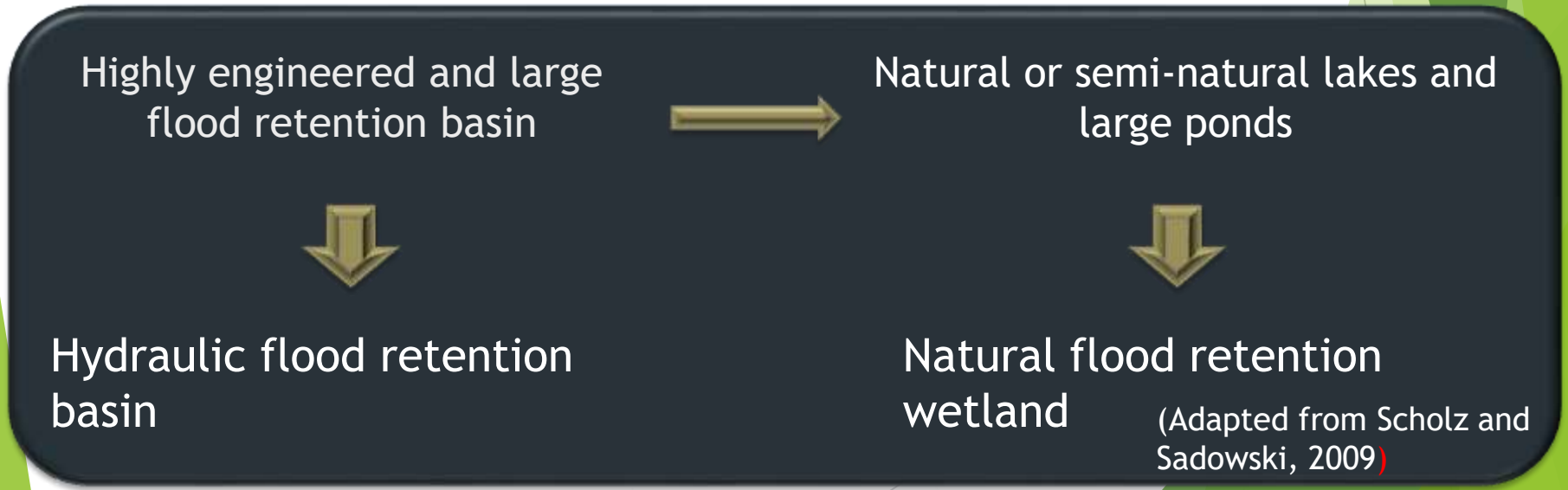
LDDs preferentially trap medium and coarse sands; finer sized sediments are then deposited in the sedimentation basin



Quick recover after a fire.
Myronidis (2015)

structural approaches to flood alleviation?

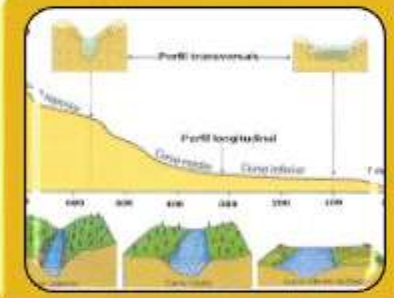
Flood retention basin: any structure that provides peak flow attenuation by storing a certain volume of water



Aspects that are central in retention system planning

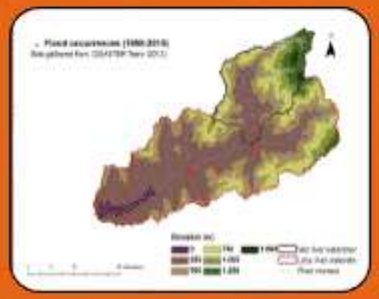
The size of the structure

- Required storage volume linked to the characteristics of the catchment
- drainage area, climate, topography and land use



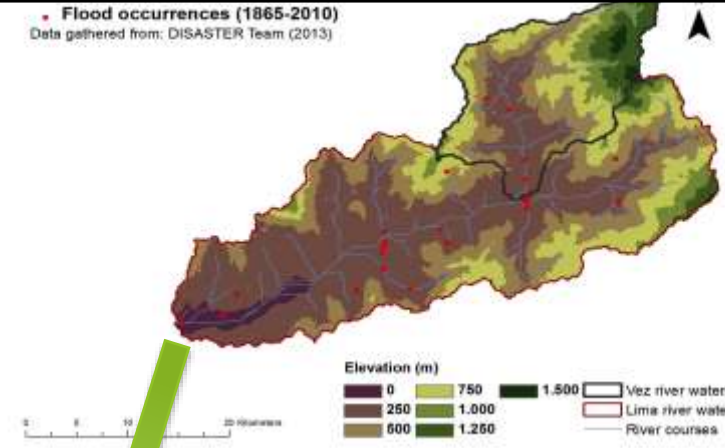
The selection of suitable locations

- In this research, we present a new approach for the dimensioning and the selection of suitable/optimal locations of flood retention basins



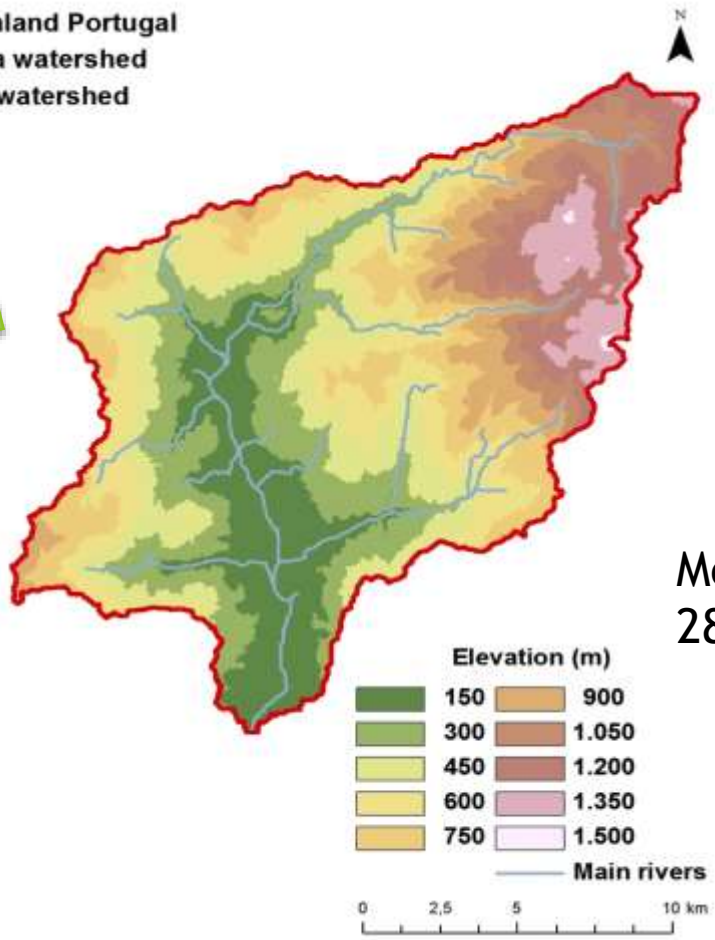
Case study: the flood-prone watershed of the Vez

- Upper part of R. Lima Catchment



Two of the 22 critical areas for flood occurrence are in the Lima watershed (APA)

Study area: Vez river watershed

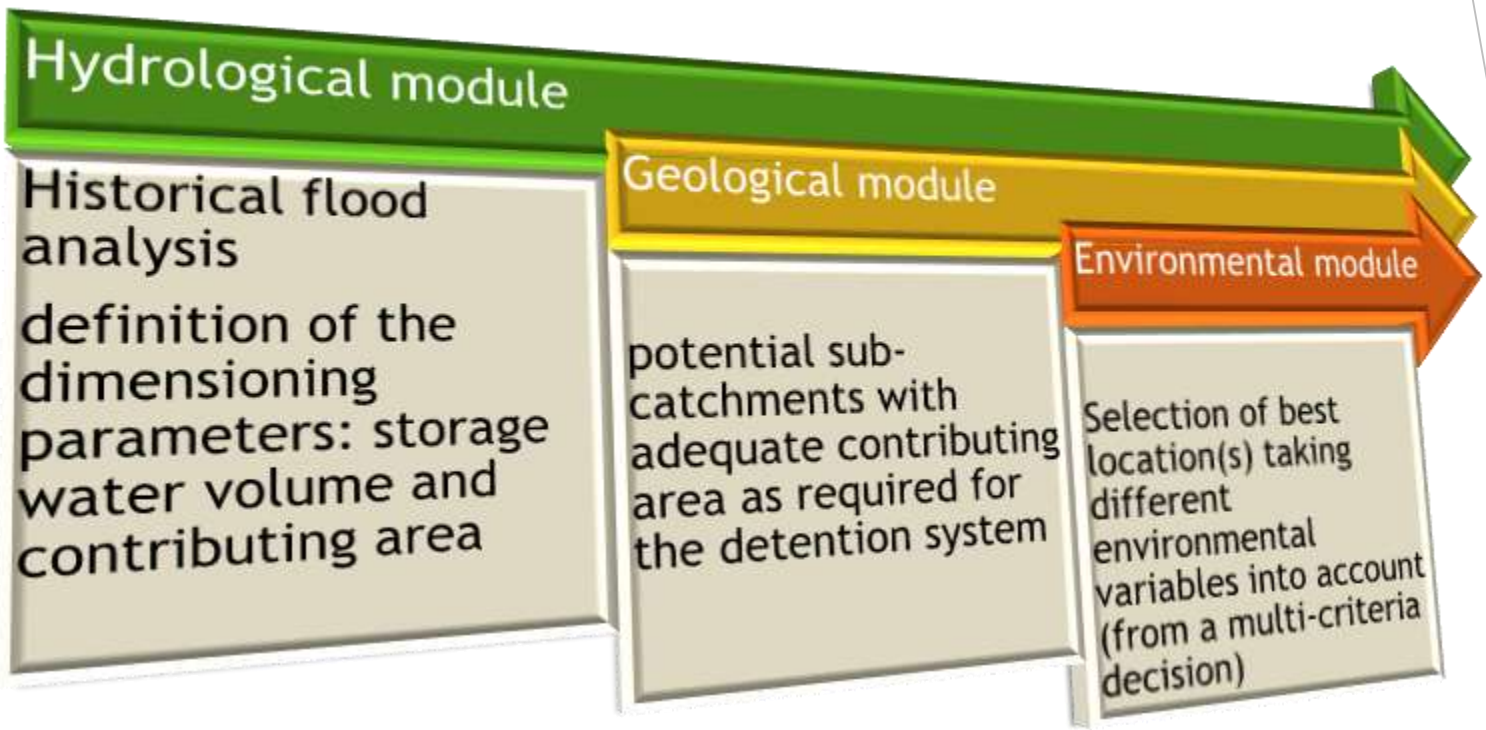


Watershed area: 263 Km^2

High annual rainfall: 2375 mm (mainly concentrated in autumn and winter)

Mean slope: 28%

General framework of our methodology comprises three steps:



Scenario analysis.: 1, 3, 5…dams??

Scenario	V (× 10^6 m^3)	A (ha)	Z (m)	h (m)
1	26.0	3362.0	84	70
3	8.6	1203.0	902 726 320	50 100 120
5	5.2	761.0	919 919 299 878 46	40 50 90 80 40

Required storage volumes (*V*)
Related contributing areas (*A*)
Outlet elevations (*z*)
Dam heights (*h*)

INCREASING INFILTRATION RATE

- ***Mulching (*particulate OM, namely forest residues, like tree leaves and chopped bar bark and straw)**

***Hydromulching*: aqueuos mixture of organic fibres with seeds, nutrientes, soil binding agentes, and greeds from a jet hose.**

PAM –Anionic Polyacramydes
a family of flocculant agentes, apllyed as dry granulate

The application of granular PAM to the soil surface is a promising and cheap method to reduce post-fire soil erosion in soils with different properties.

- ***Emergence seeding***
  faster growing heguminous herbaceous plants (with fertilizations)
- ***Plantation***
  srhubs
  trees

PAM –Anionic Polyacramydes application norms

Excessive application of Anionic PAM can lower infiltration rates or increase suspended solids in water. More is not better!

For Anionic PAM to work effectively there must be a source of “divalent cations.” Gypsum (CaCl2) is a common source. The divalent cation source may be in the Anionic PAM mix, in the soil, or applied directly to the soil.

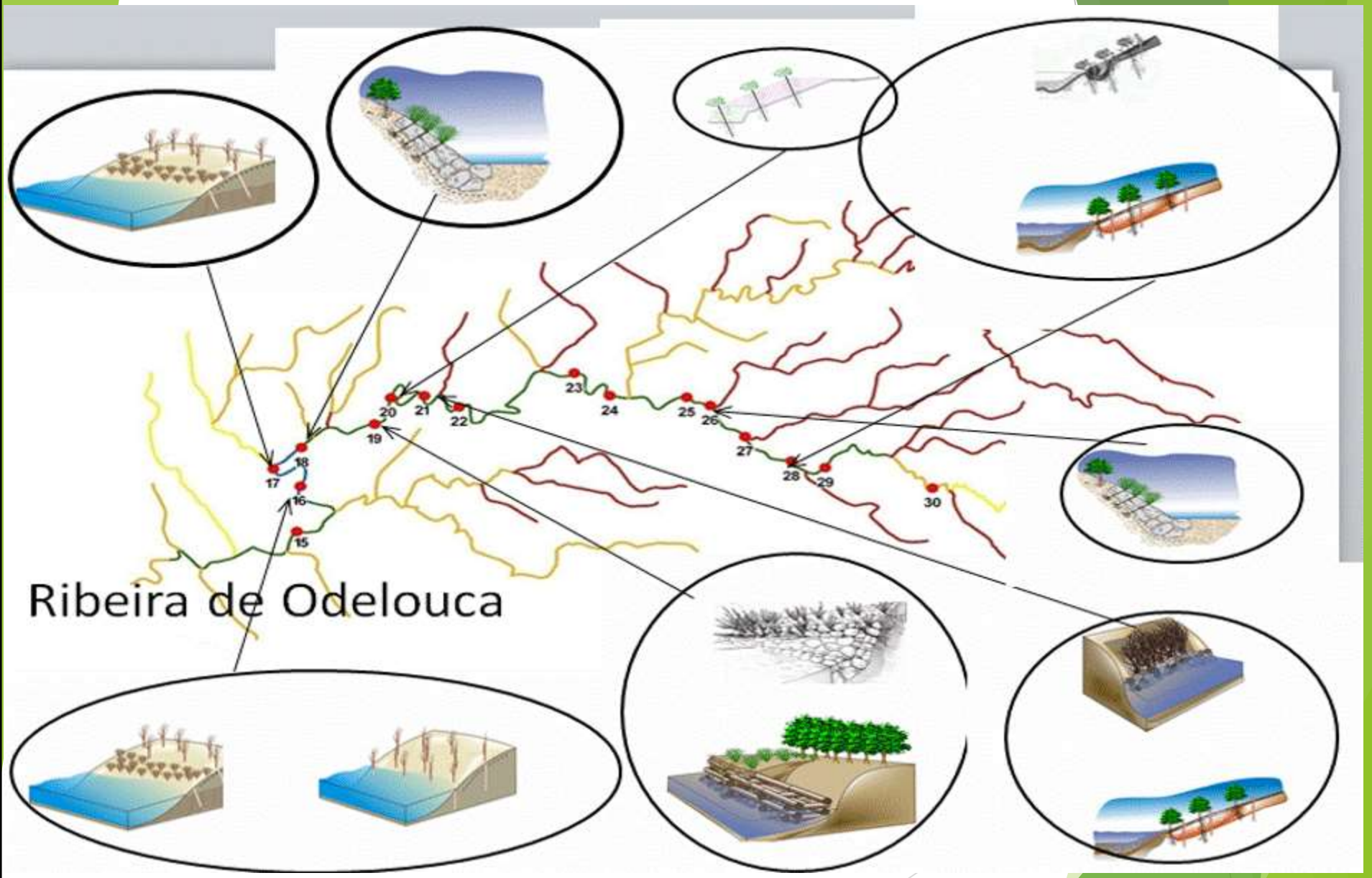
The Anionic PAM mixture should be prepared immediately prior to application as effectiveness decreases if too much time passes between mixing and application.

Application to dry soil is preferred but wetting the soil with a relatively low rainfall amount and intensity after the application of PAM helps to maximize the effect of the PAM on soil loss throughout the rainy season.

PAM, hydomulching and hydroseedling application

PAM –Anionic Polyacramydes application norms

Soil engineering to protect slopes, banks and restore riparian layers


Ribeira de Odelouca
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R. Odelouca (Algarve): bank stabilization and giant reed removal

Maio 2013

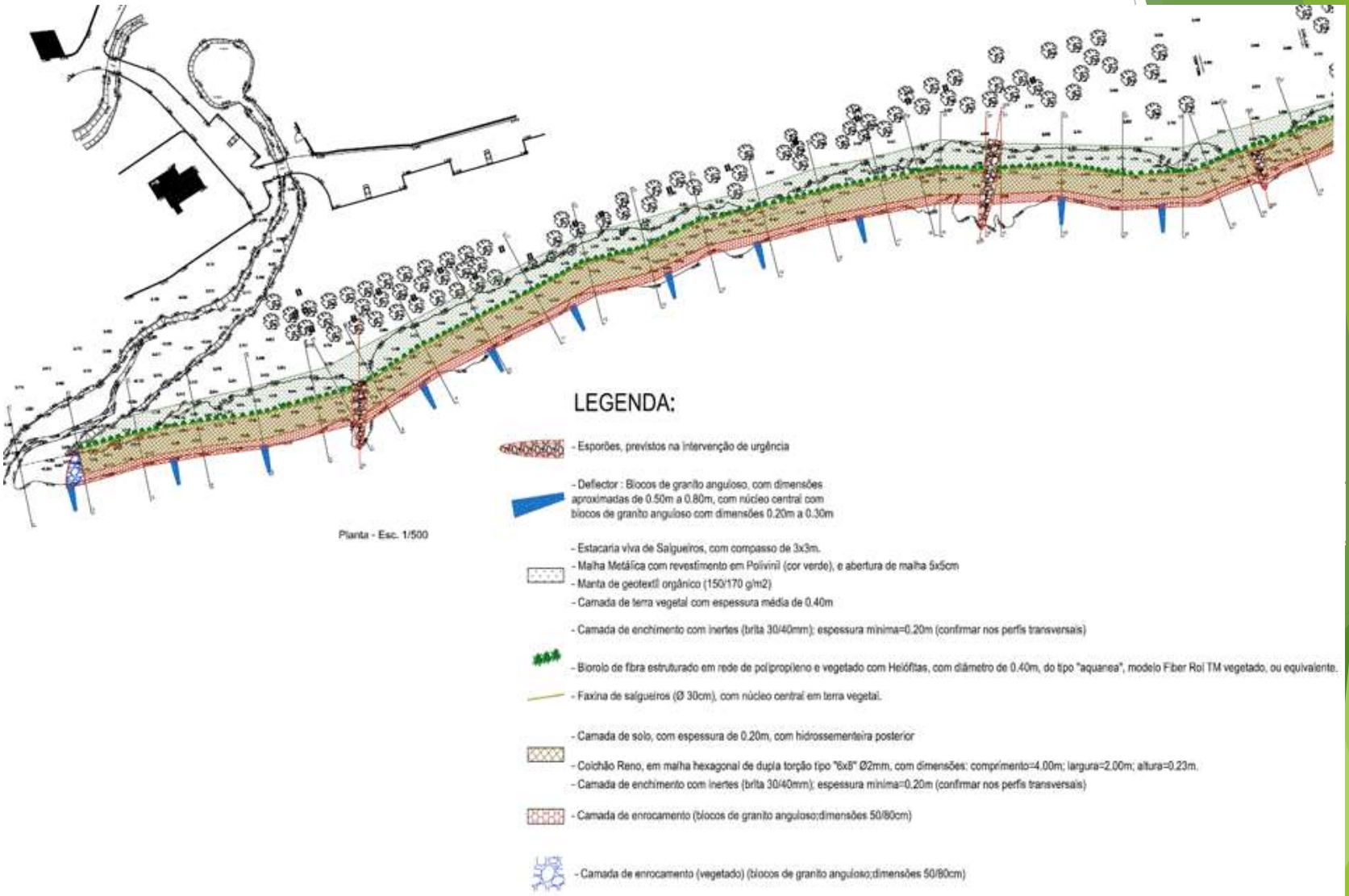
After
3 years…

Floods affect urban areas in the lower part of R.Lima catchment (photos February 2016)

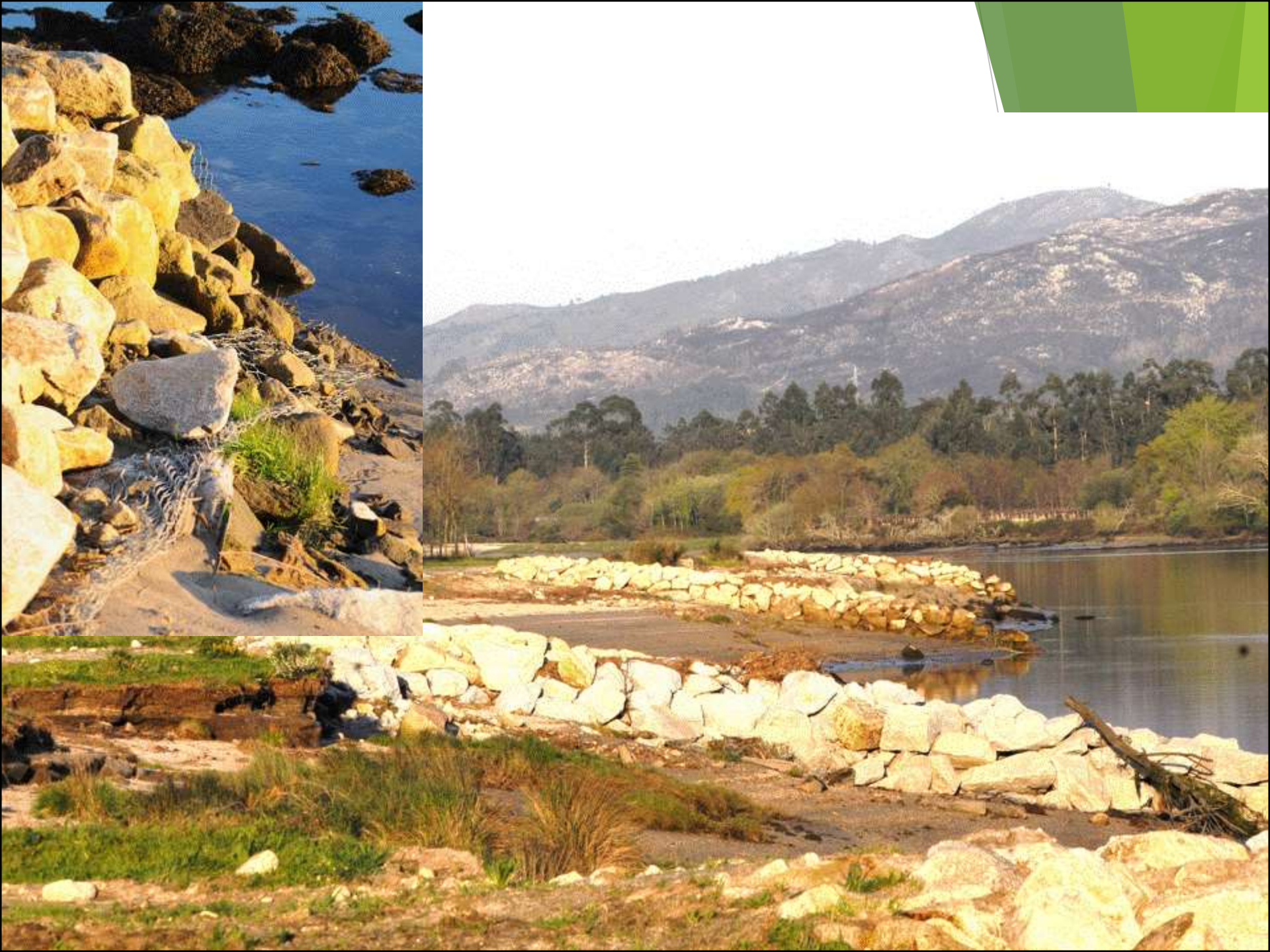
R. Lima estuary

1965 - 2010

Cardielos - 2nd stage (downstream)

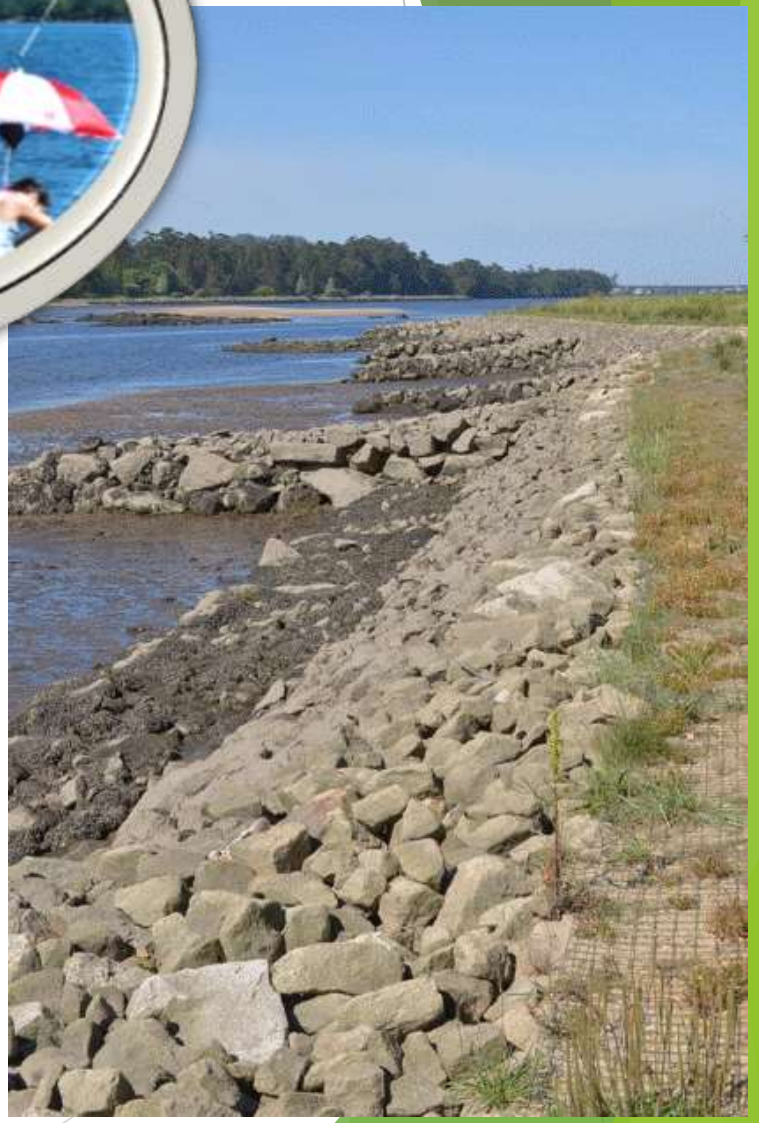


Planta - Esc. 1/500




REQUALIFICAÇÃO DAS MARGENS
DO RIO LIMA EM CARDIELOS
ÁREA EM MANUTENÇÃO
NÃO PISAR

After 1 year…



Natural Water Retention Measures (NWRM)

A2	Buffer strips and hedges	F1	Forest riparian buffers
A3	Crop rotation	F4	Targeted planting for catching precipitation
U3	Permeable surfaces	N2	Wetland restoration and management
U11	Retention ponds	N4	Re-meandering

PARABÉNS CEF 40 ANOS DE IDADE_A MATURIDADE

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40 years