



NWR OF FORESTS AND CLIMATE CHANGE ADAPTATION

Ivan Pilaš, Croatian Forest Research
Institute

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Anancy

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Mappe

Alpine

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Black Sea

Boreal

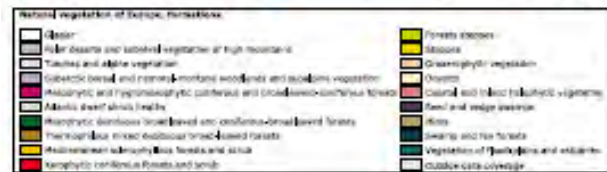
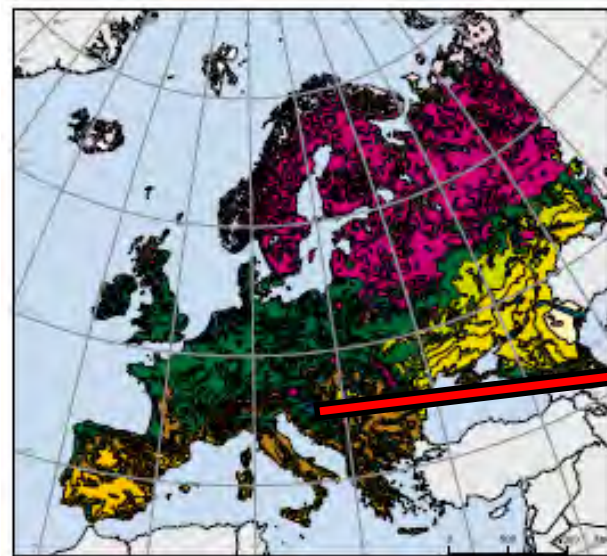
Continental

Mediterranean

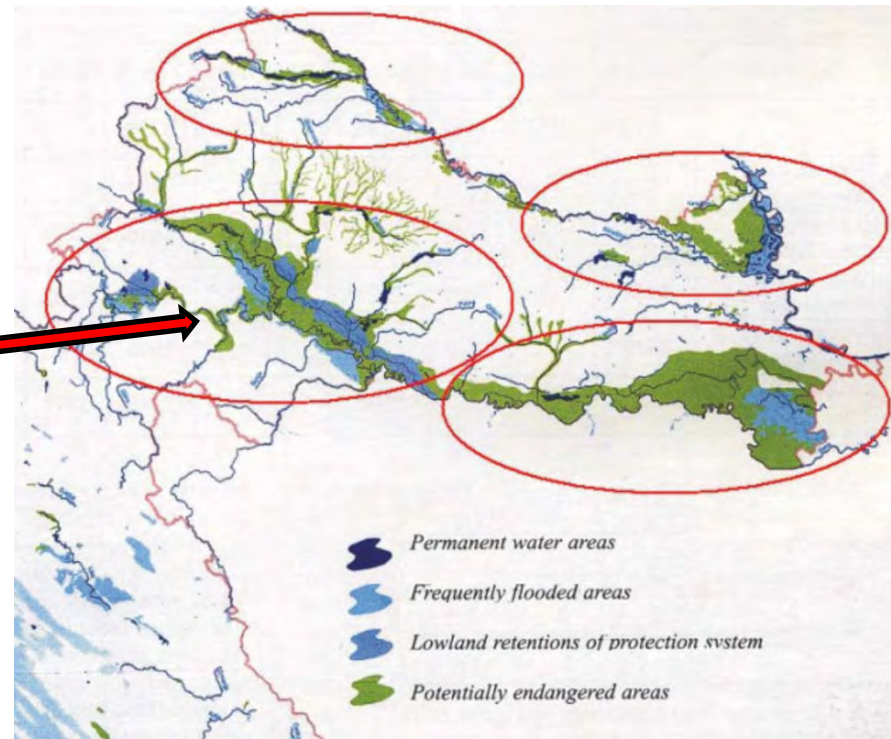
Pannonian

Steppic

Sava river (Croatia) – using natural floodplains as NWR for flood protection



Source: Balci et al., 2007.

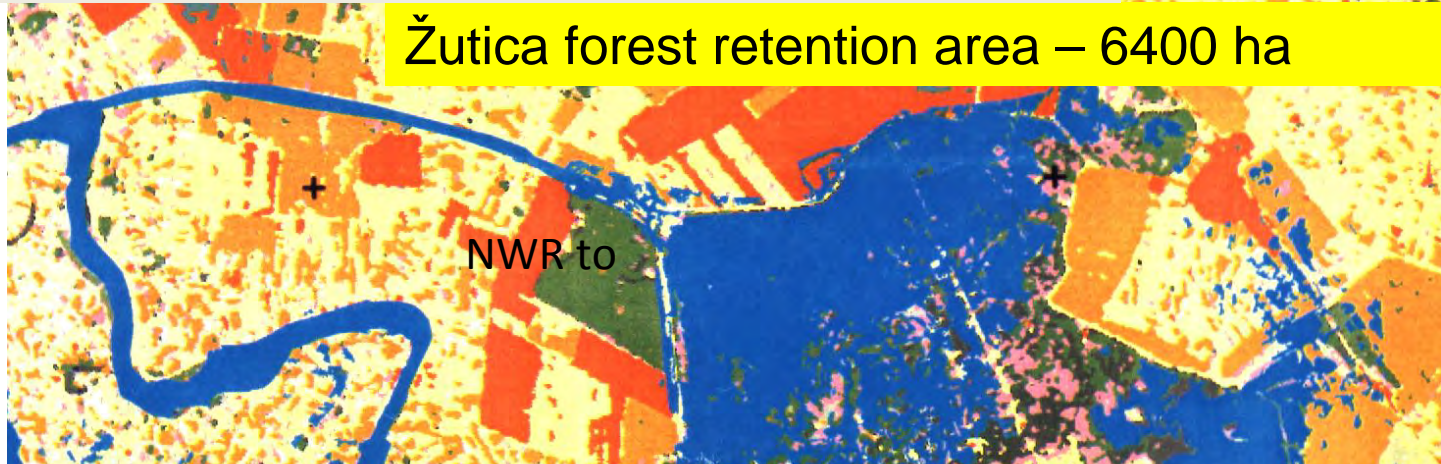


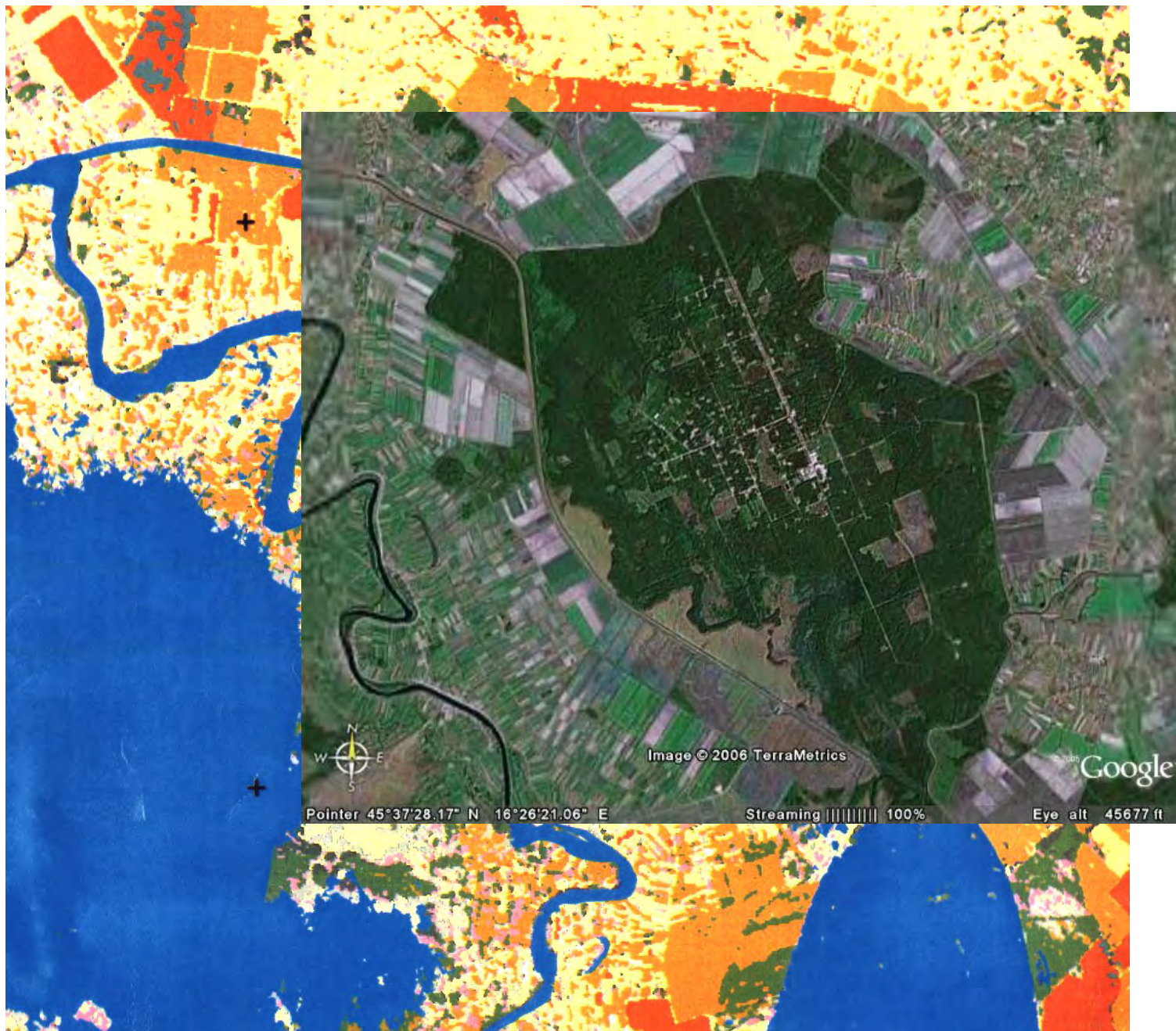
- The largest complex of alluvial floodplain wetlands in the Danube basin and the largest lowland forests
- The Sava is a unique example of river where the floodplains are still intact, supporting both floods alleviation and biodiversity (NATURA 2000 areas)



NWR in support of flood protection

Žutica forest retention area – 6400 ha





NWR in support of biological conservation

DANUBE PARKS is a network of protected areas along the Danube River that constitute unique natural areas of ecological, scientific and cultural importance on an international scale.

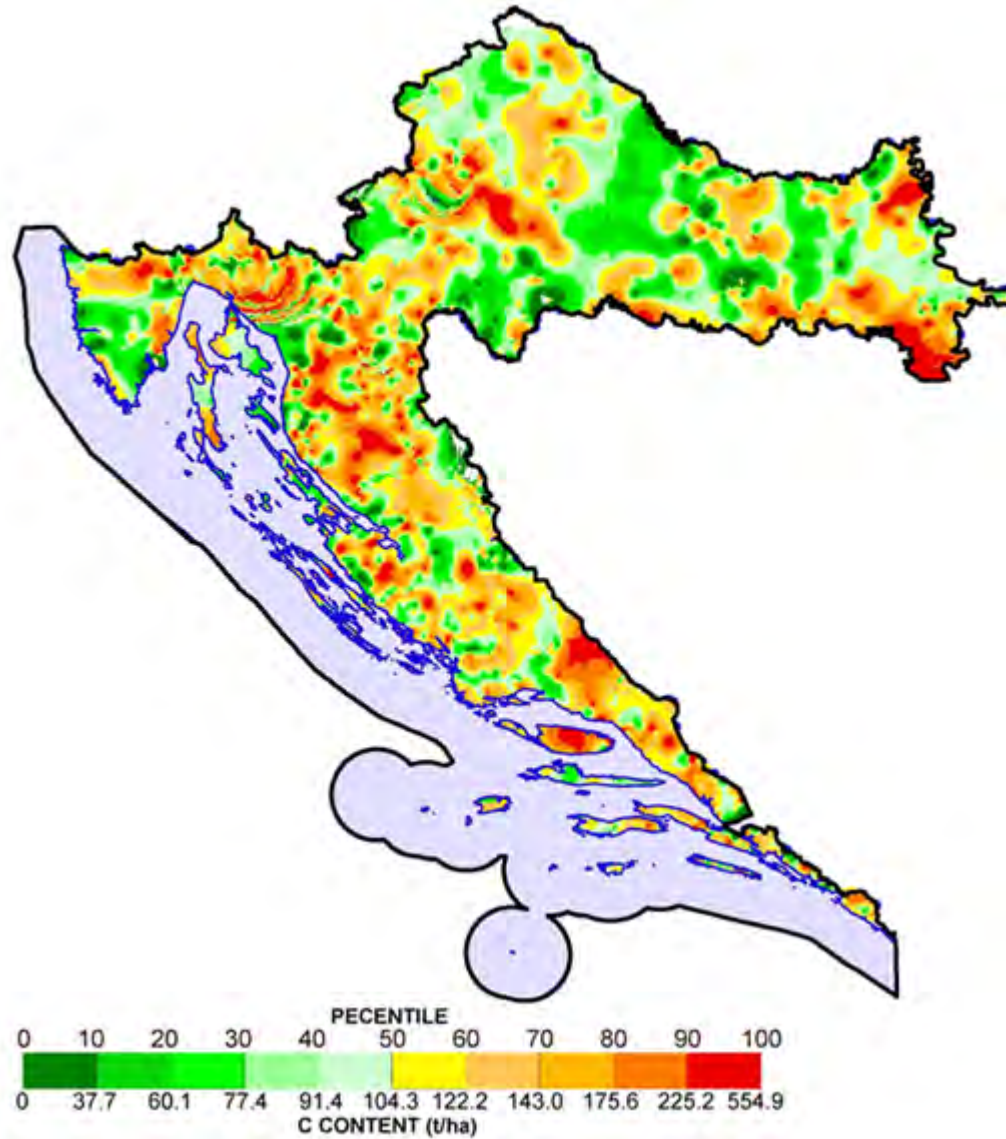




NWR in support of timber production



NWR in support of carbon sequestration





Genisto elatae-Quercetum roboris

Humogley
(Ritska crnica)

histic, molic
GLEYSOL,
humic, eutric





Genisto elatae-Quercetum roboris

Eugley

(Močvarno glejno,
amfiglej)

folic,
GLEYSOL,
clayic





Frangulo alnetum-glutinosae

Eugley

(Močvarno glejno,
amfiglej)

mollic

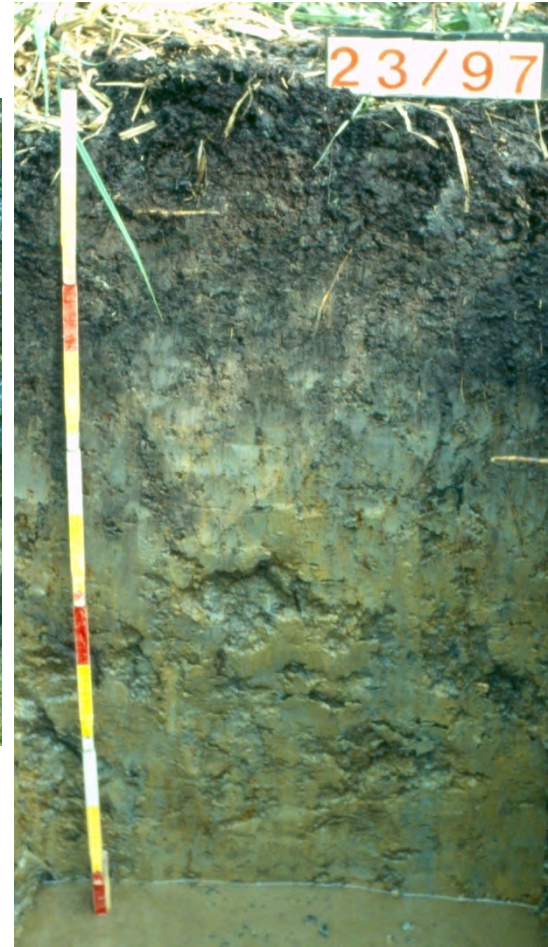
GLEYSOL

vertic, stagnic





Frangulo alnetum-glutinosae



Eugley
(Močvarno glejno,
amfiglej)

mollic
GLEYSOL,
vertic, stagnic



Genisto elatae-Quercetum roboris

Eugley
(Močvarno glejno,
epiglej)

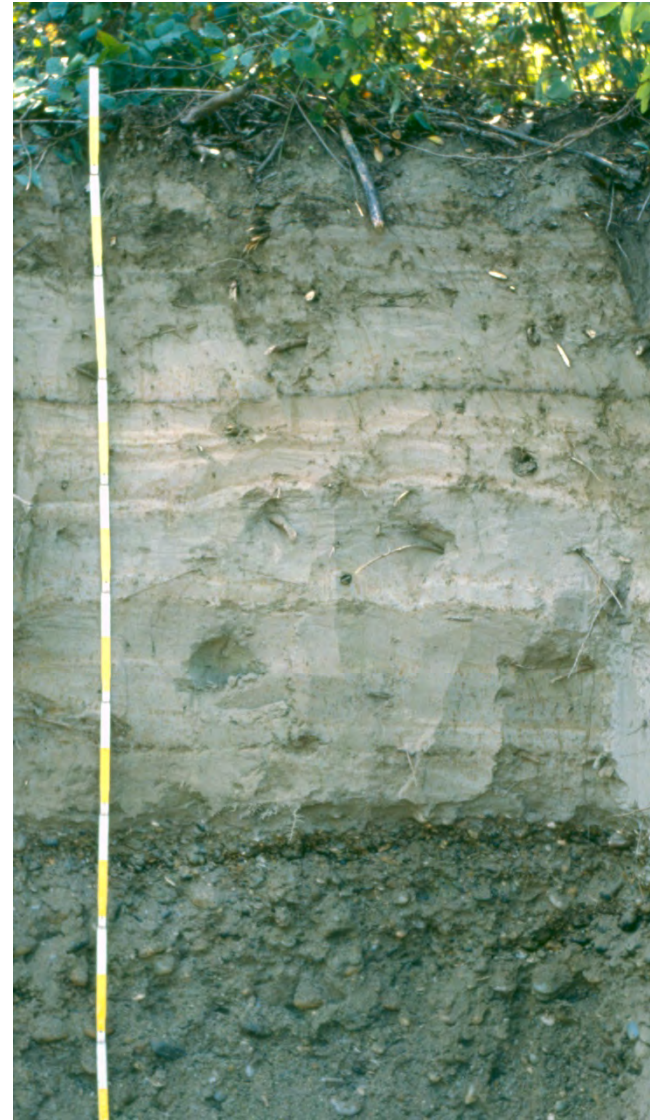
GLEYSOL,
vertic
stagnic

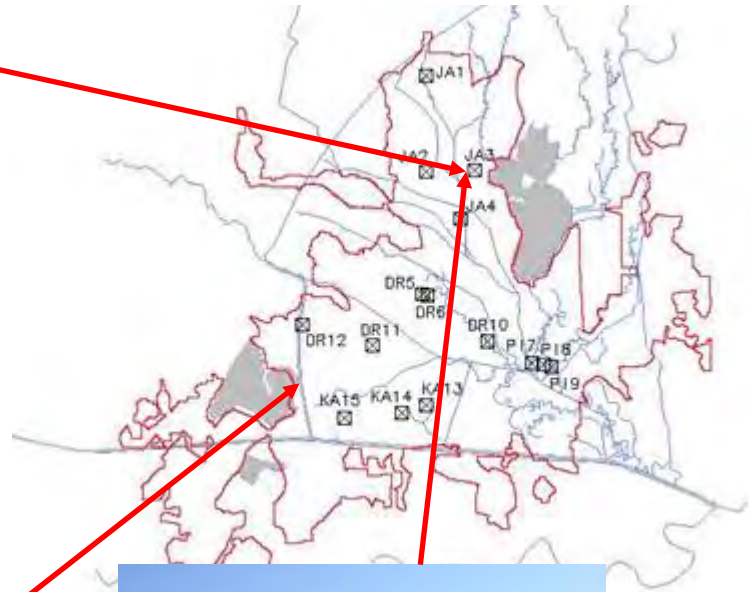




Salici-Populetum

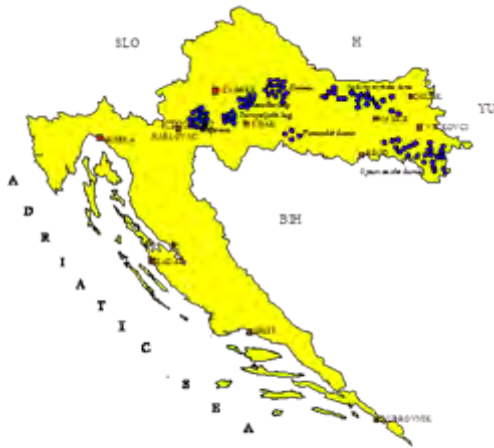
Fluvisol
(Aluvijalno tlo) **folic,**
FLUVISOL,
siltic, endoskeletal



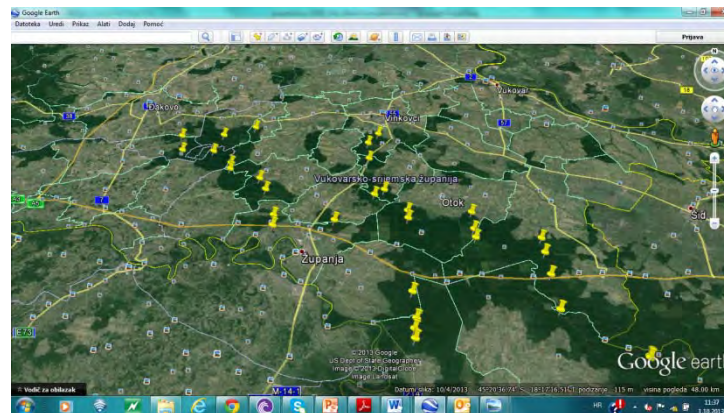


CROFHIS – Forest Hydropedological Information System

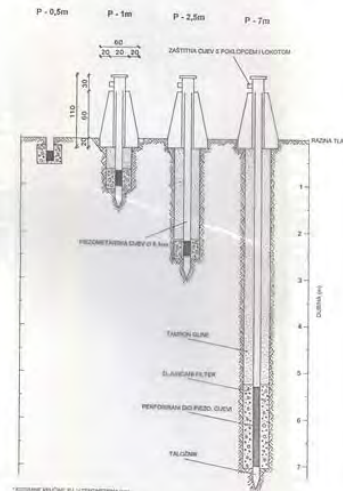
LOKACIJA POSTAJA U HRVATSKOJ



● Piezometrijske postaje

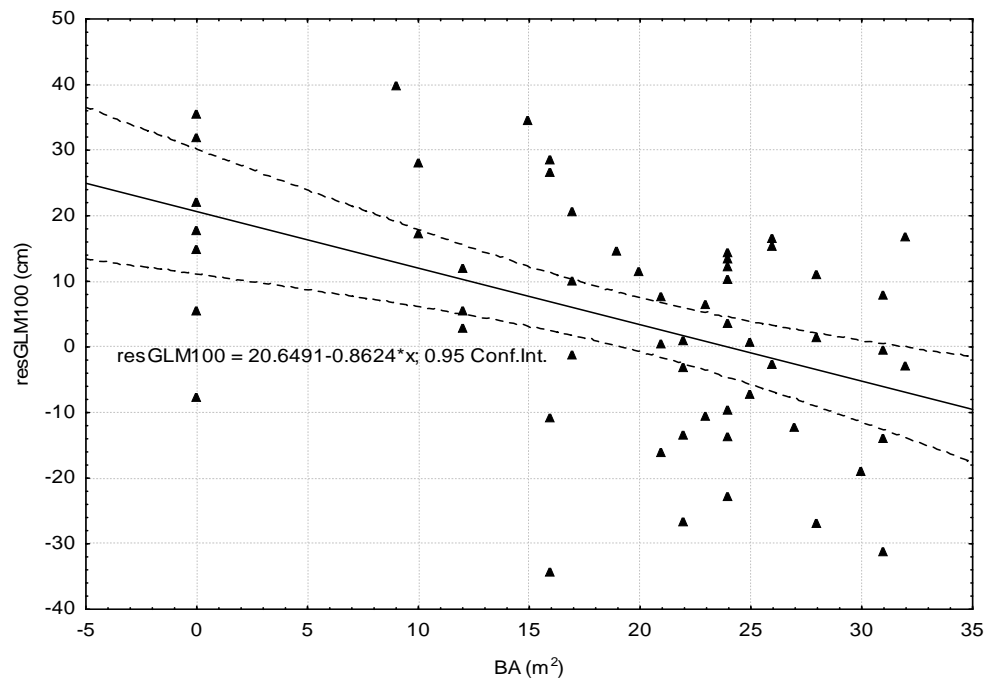


ŠKICA BATERIJE PIEZOMETARA NA JEDNOJ VODOMJERNOLJ LOKACIJI (STACIONARU) U NEZISKIM SUMAMA U Š. NAŠICE (1994)

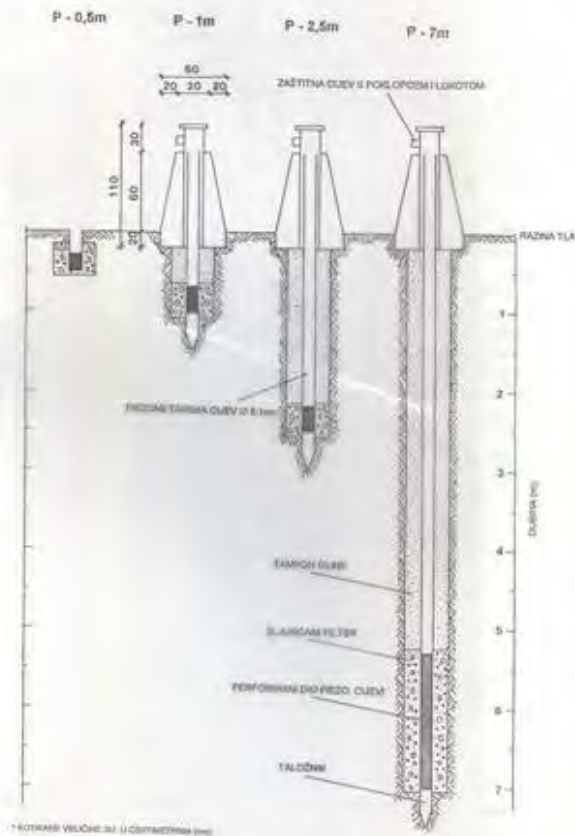


SILVICULTURAL PRACTICE

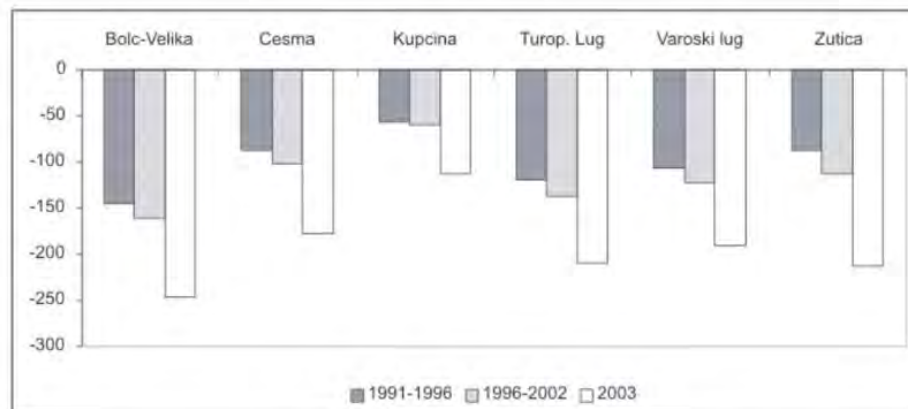
Relationship between stand density (basal area - BA) and waterlogging



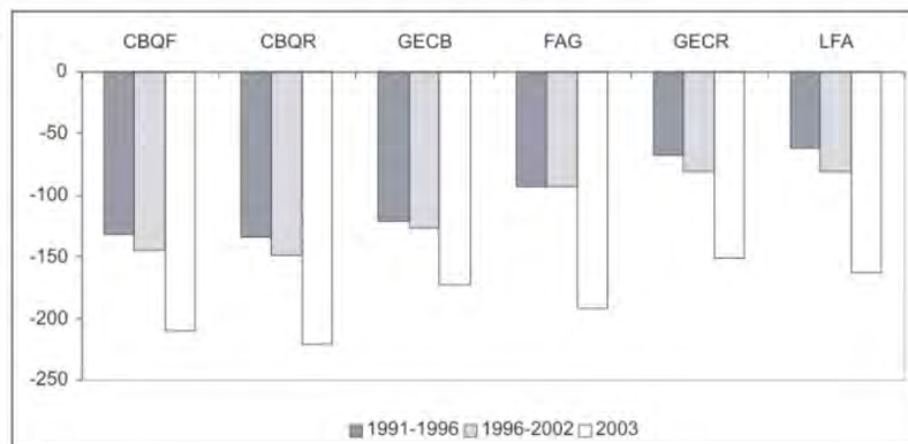
SKICA BATERIJE PIEZOMETARA NA JEDNOJ VOODOJERNOJ LOKACIJI (STACIONARU) U NIZINSKIM SUMAMA U.S. NAŠICE (1994)



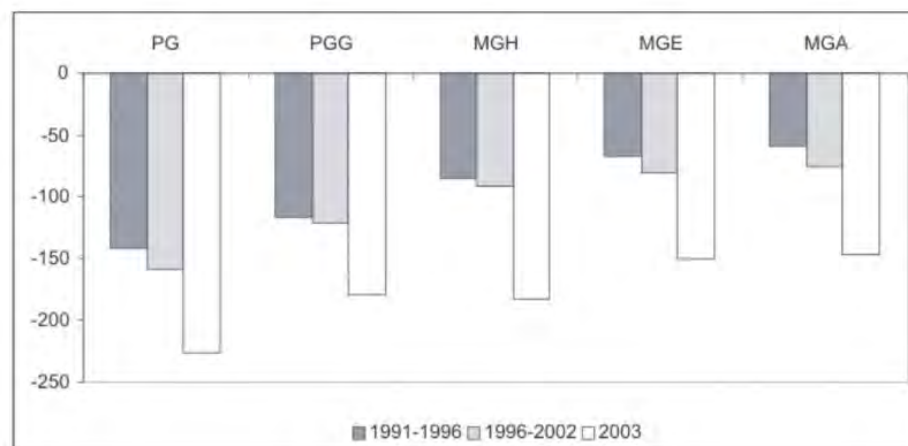
a)



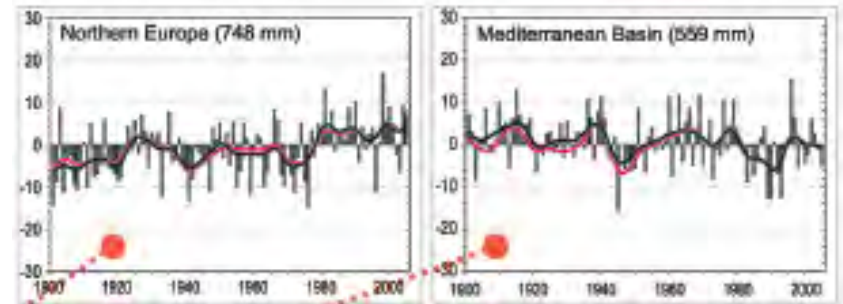
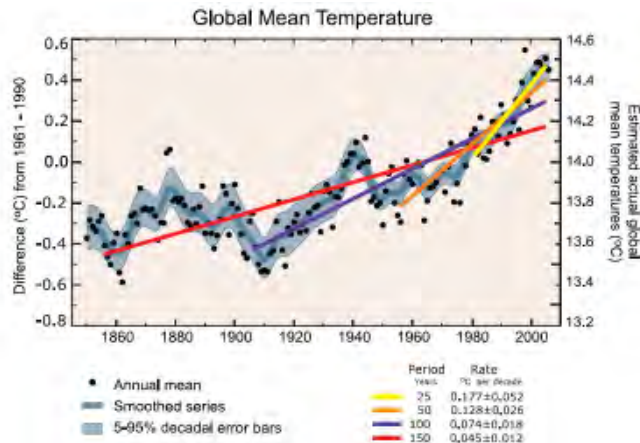
b)



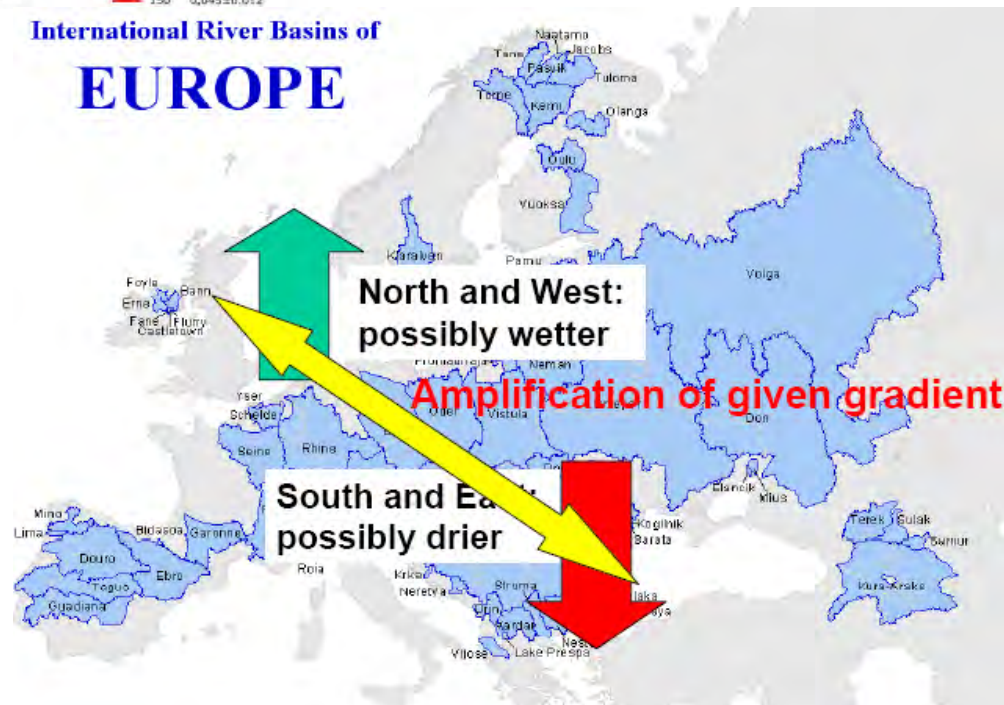
c)



Climate change

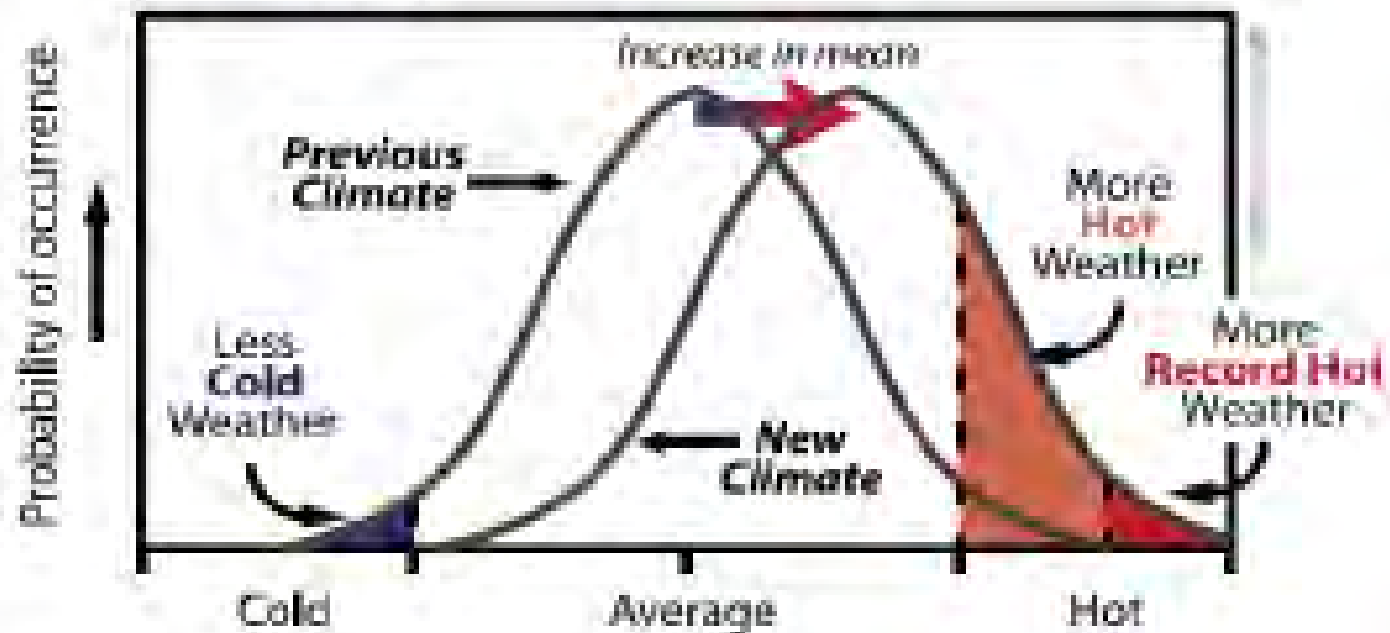


International River Basins of EUROPE

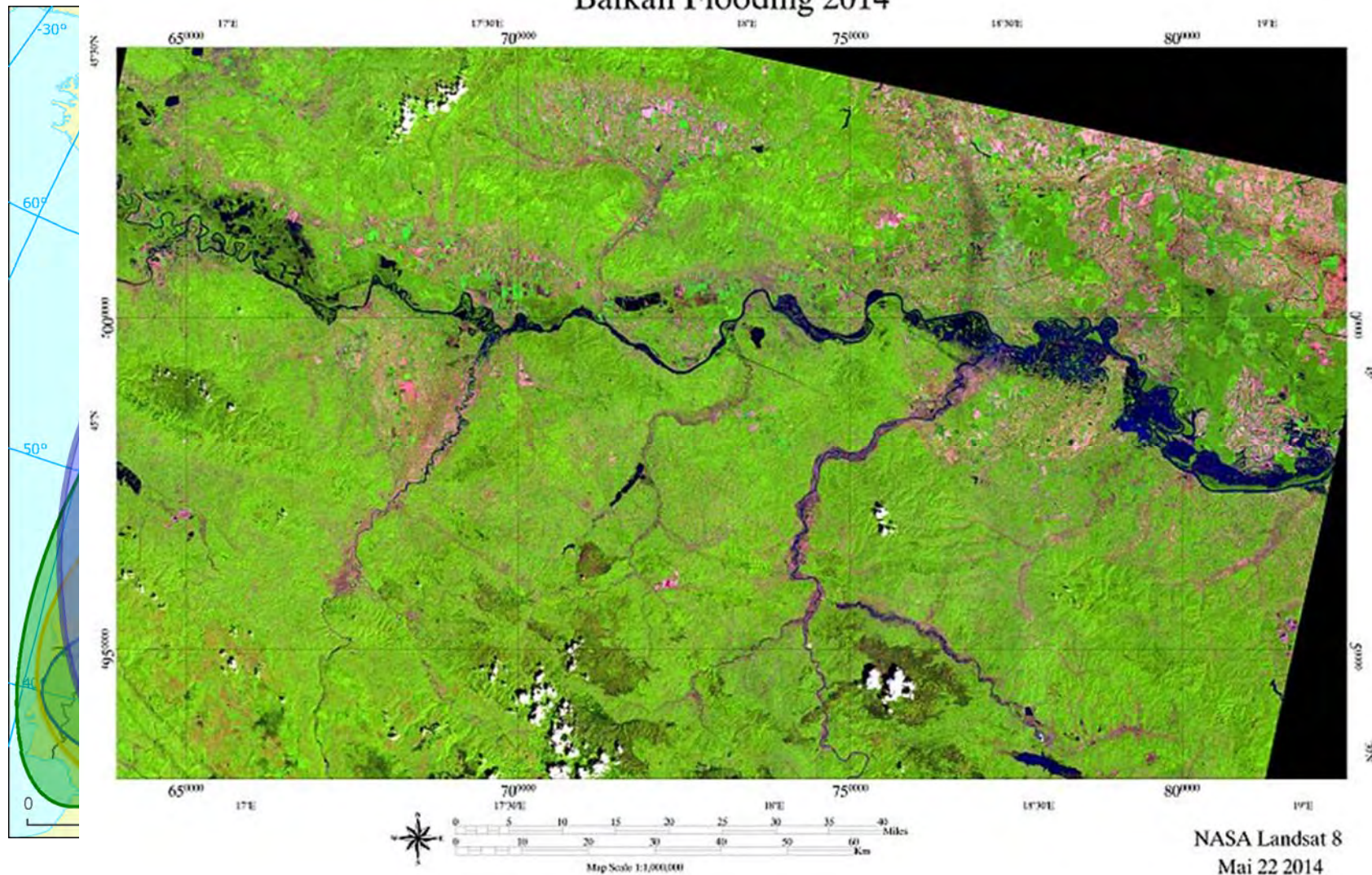


Extreme events

Theory

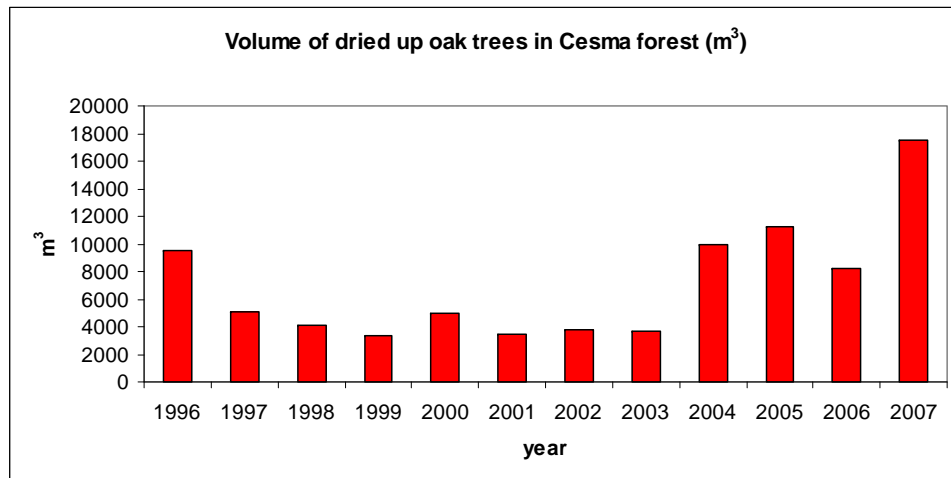


Balkan Flooding 2014

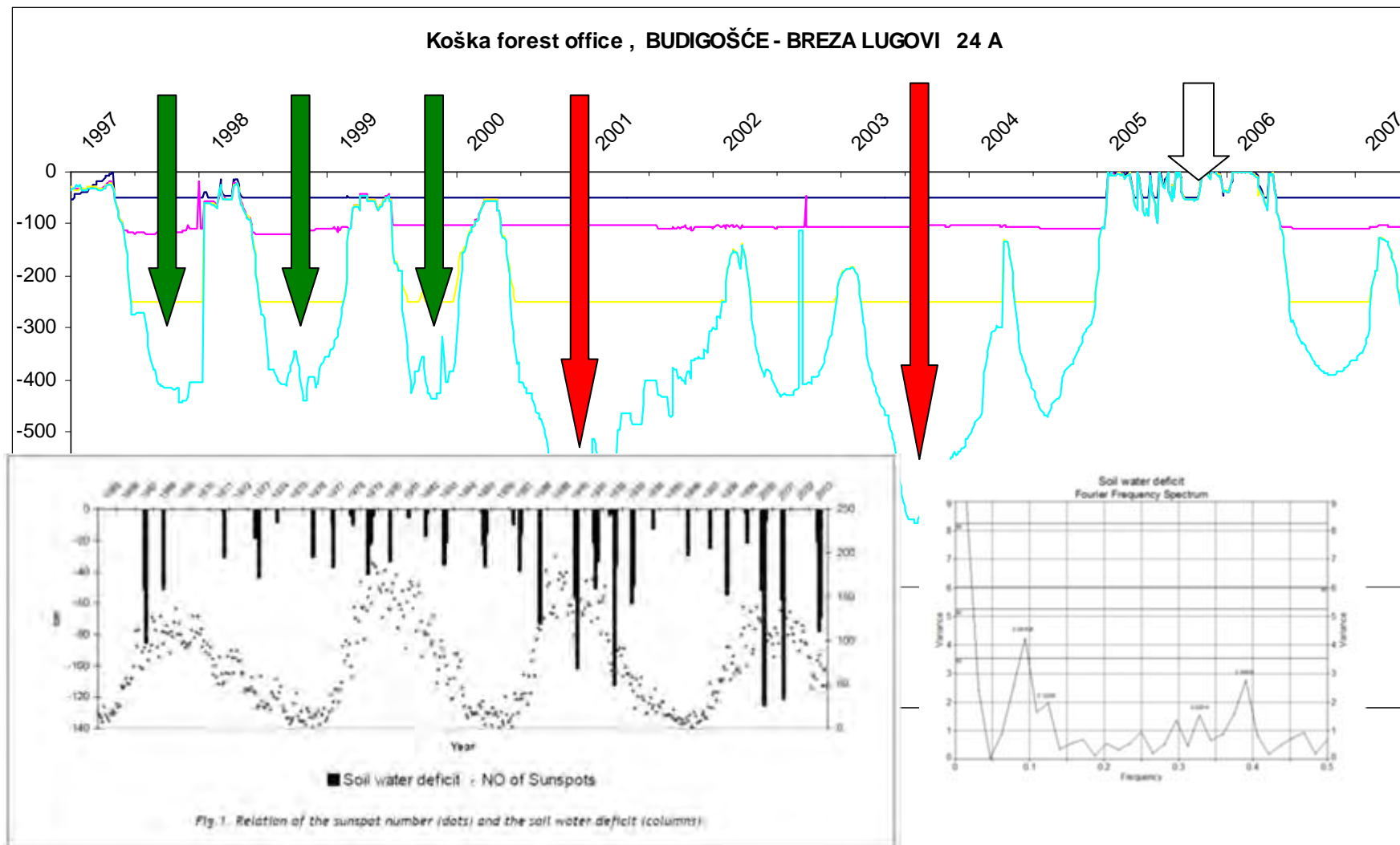




NWR against Forest dieback in Česma forest (1996-2007)



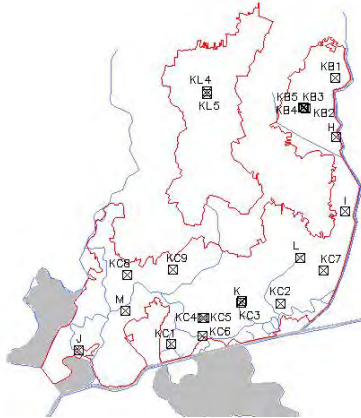
Characteristic pattern of groundwater series



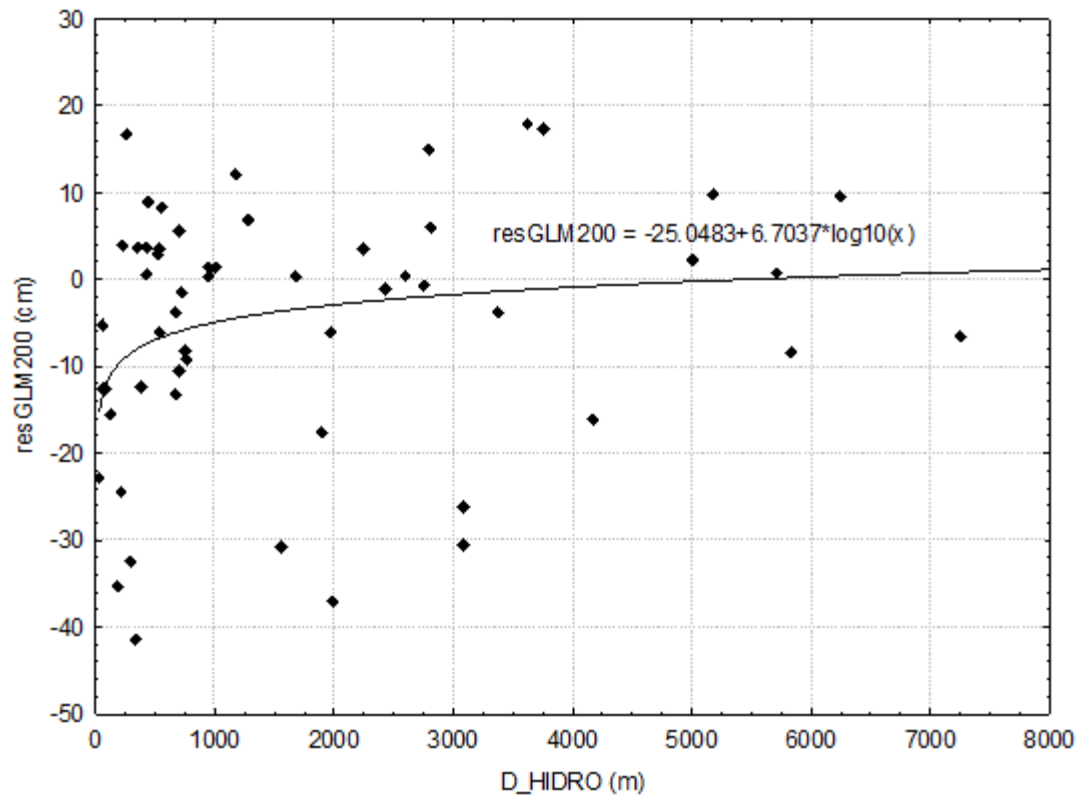
D. Roša, I. Pilaš, J. Roša, B. Vršnak, D. Maričić, D. Hržina

The Relationship between solar Activity and Soil Water Balance. Sun and Geosphere, 2009; 4(1): 31-34

- Groundwater monitoring in the area of Vrbovec (Česma forests) :
Northwestern Croatia

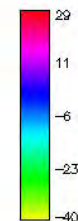
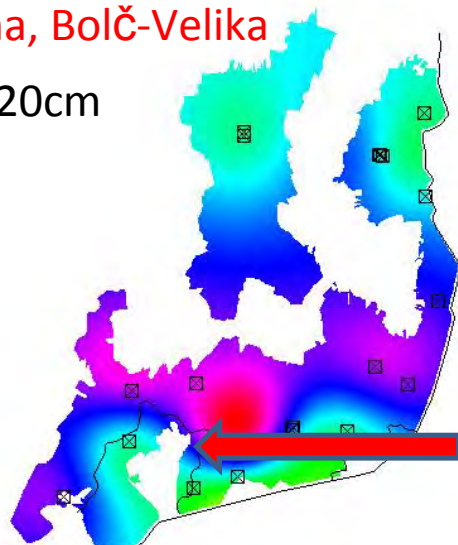


Decline of groundwater table in dependance to the large channels

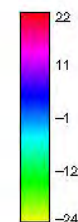
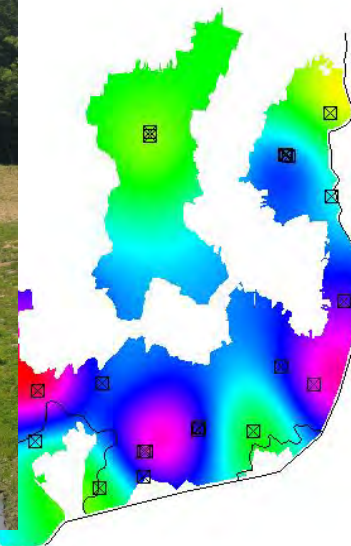
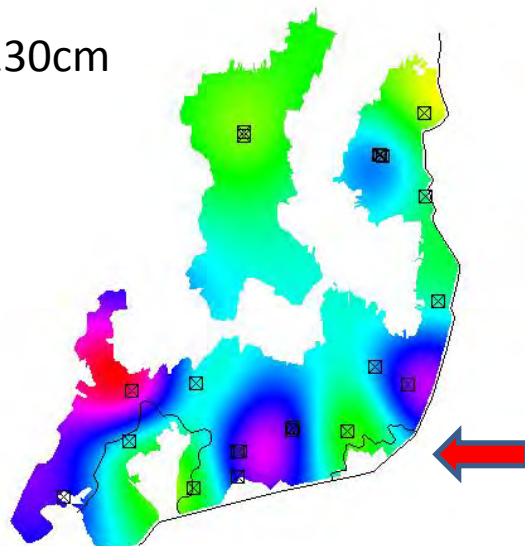


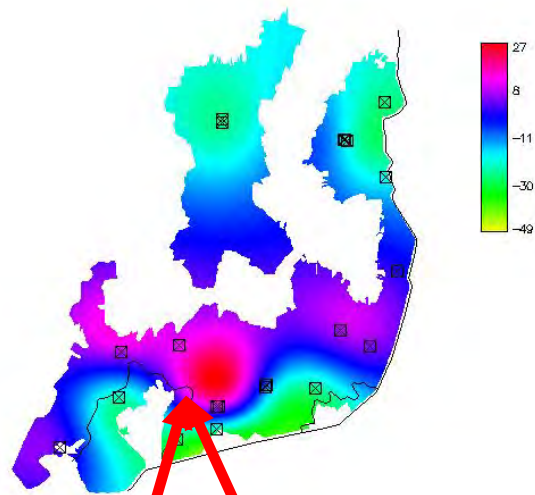
Česma, Bolč-Velika

20cm



130cm









Druga akumulacija u Česmi 2009



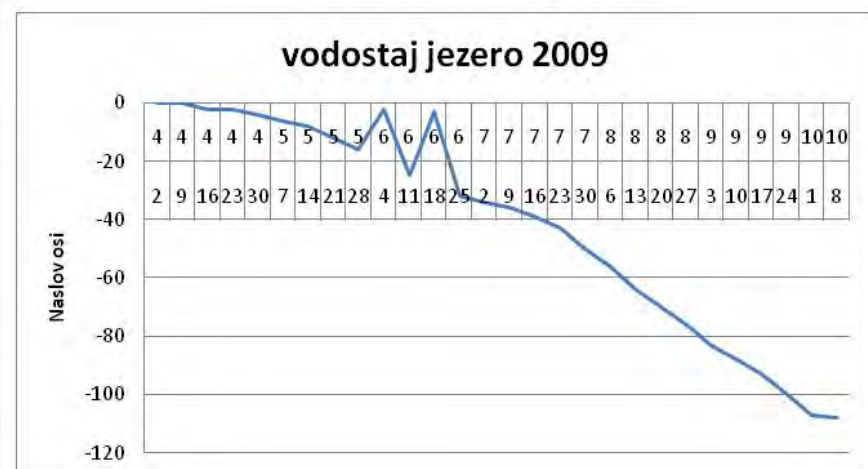
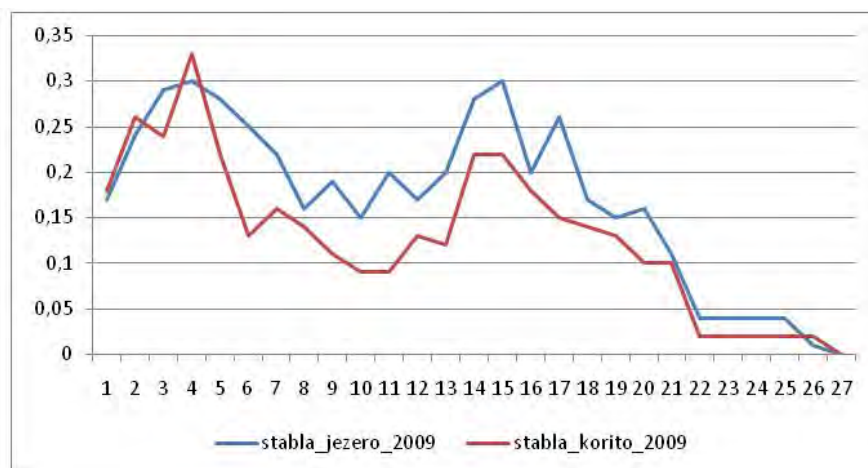
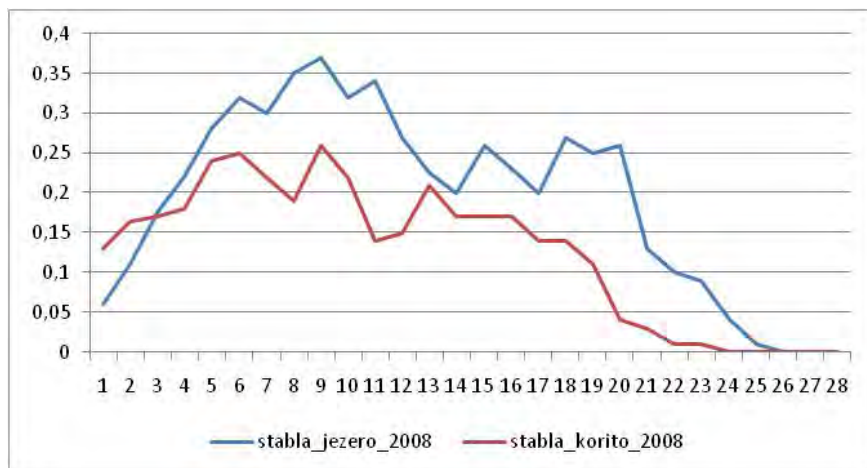








Intraannual variations of stem diameter



Forests and NWR

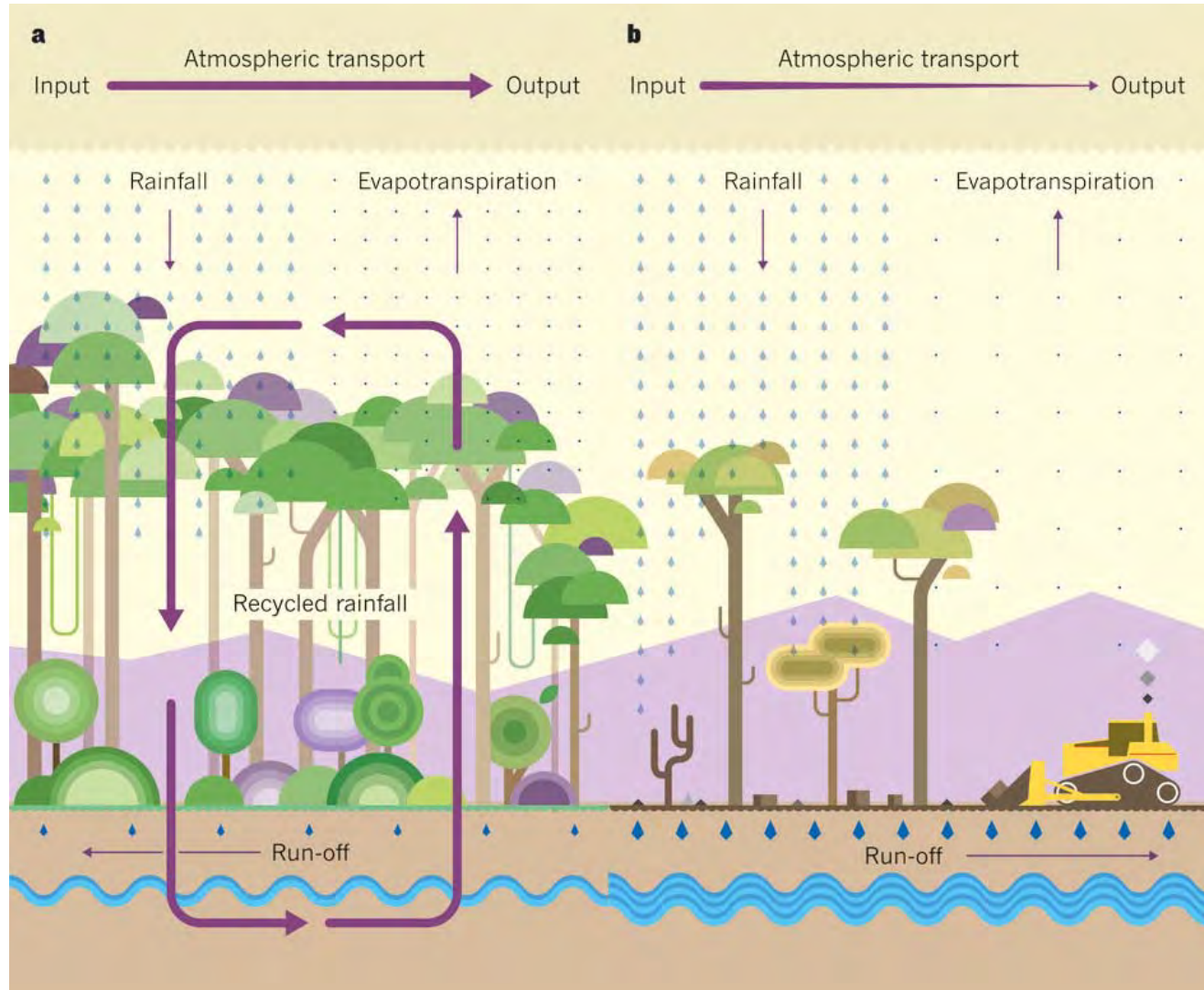
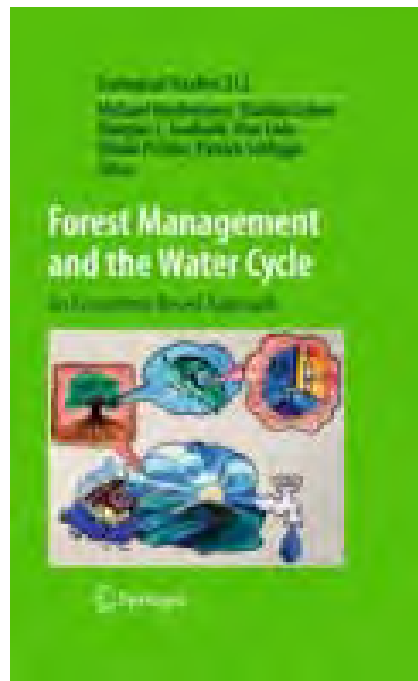


Table 2.1 Impact of forest management measures on drinking water quality and quantity indicators (* low impact, ** medium impact, *** high impact)

Forest management measure / Indicator	Concentration of pollutants in the water	Nitrogen content in the water	Sediment loss (erosion)	Runoff	Water temperature
Clear cut area	*	***	***	***	***
Frequency, intensity, technique of harvesting	***	*	**	**	*
Tree species composition	**	***	**	***	*
Crown density, cover percentage	*	***	***	***	**
Distribution of growth classes	*	**	**	**	***
Vertical and horizontal stand structure	*	**	**	**	*
Forest regeneration, ground vegetation	*	**	**	**	*
Coarse woody debris	*	**	*	*	*

Pilaš, I., Fager, K.H., Vilher, U., Wahren, A. 2011. Multidimensionality of Scales and Approaches for Forest-Water Interactions in: Bredemeier, M., Cohen, S., Goldbold, D.L., Lode, E., Pichler, V., Schleppi, P. (Eds.), Forest Management and the Water Cycle: An Ecosystem-Based Approach, Ecological Studies 212, DOI 10.1007/978-90-481-9834-4_1, © Springer Science+Business Media B.V.



Lithosol



**Lithic, hyperskeletal
LEPTOSOL,
calcaric, skeletal**



Regosol

**leptic
REGOSOL,
calcaric,
turbic**

Pinus nig





Orno-Quercetum ilicis

Calcocambisol

leptic,
CAMBISOL
rhodic





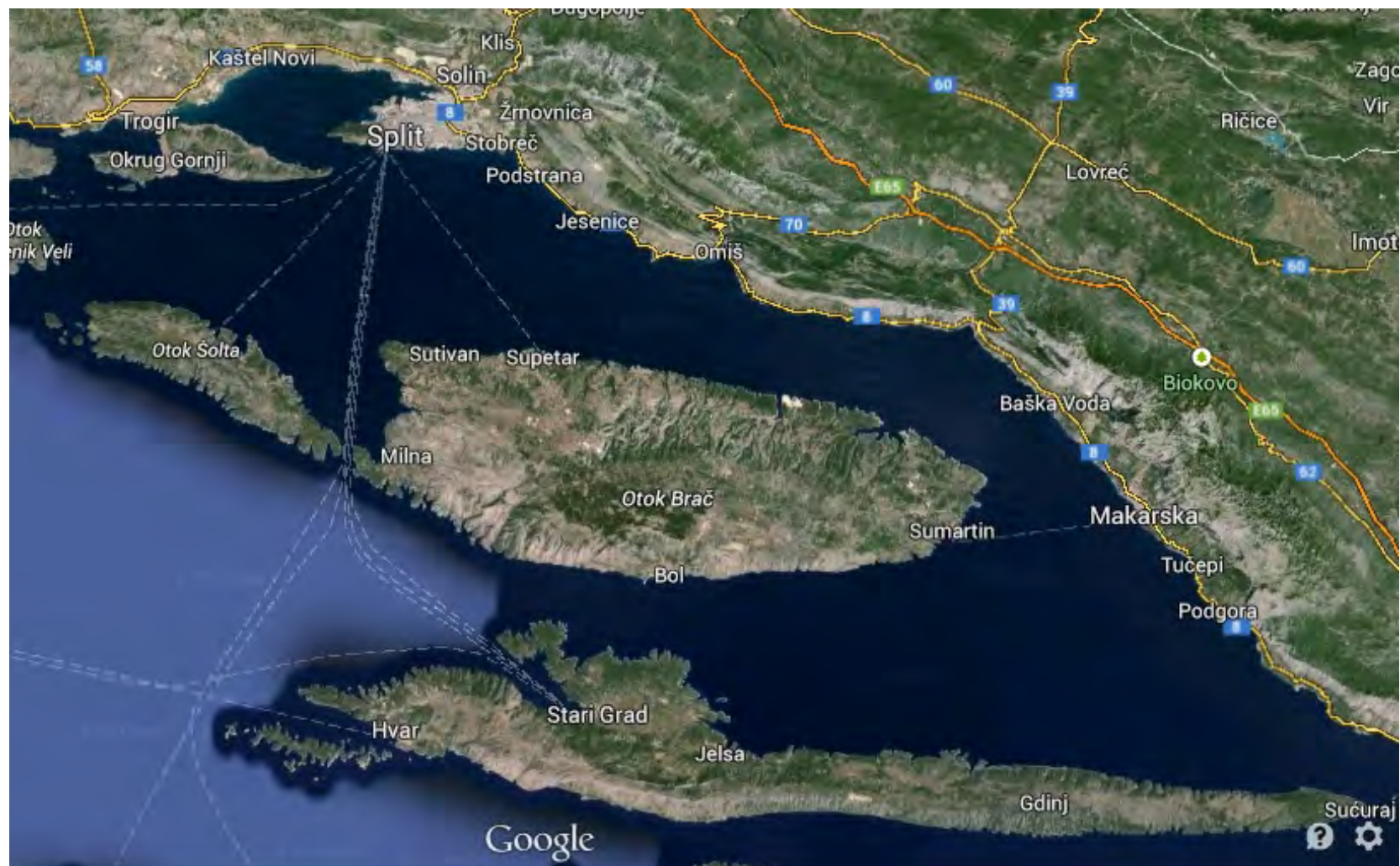


Oznaka plohe	Depth (cm)	N (mg/g)	C (%)
P6	0-4	13	49
P15	0-4	10,2	47,94
P18	0-5	12,3	50,14
P22	0-2	9,82	50,58
P30	0-3	13,2	47,74
P33	0-2	11	50,22
Average		11,33	49,42



▪ Istočna strana još nepošumljenog Marjara s križem na najvišem vrhu. Snimljena oko 1870. godine











Croatian Science Foundation

Advanced FORest ENvironmental Services Assessment - AFORENSA

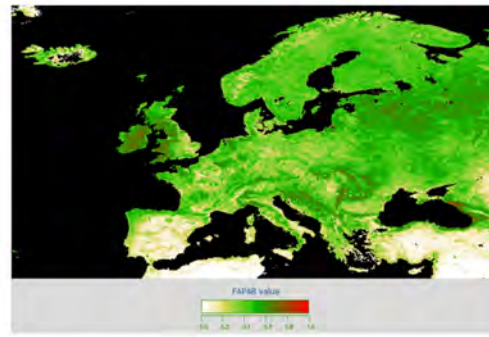
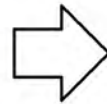
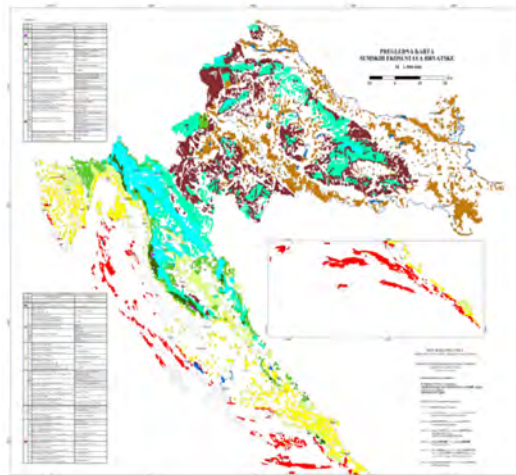
Croatian Forest Research Institute, University of Zagreb, Faculty of
Geodesy

Department of Geoinformation Science

The main objective of AFORENSA is to generate relevant knowledge how the forest ecosystems in Croatia responds to observed extreme climatic variations, and what are possible future expectations in respect to the progression of climate change and disturbances of natural hydrologic cycle with intensification of drought frequency and severity.

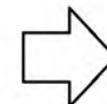
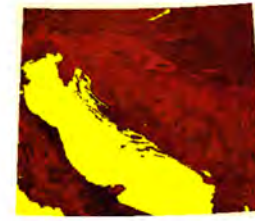
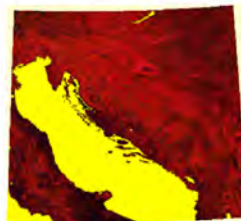
Forest vegetation and NWR

DYN-CROFOR

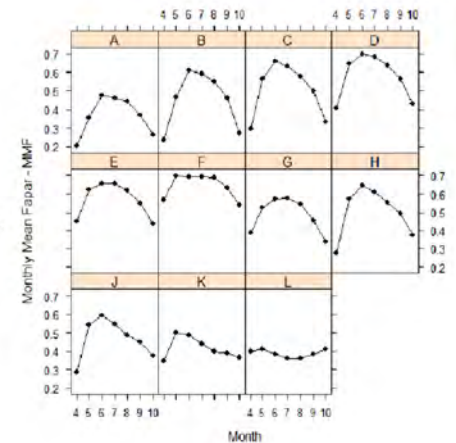


Fapar 1998-08

Fapar 1999-08



Photosynthetic activity of the main forest types in Croatia



Forest Ecology and Management 326 (2014) 58–78



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Forest Ecology and Management

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Response strategies of the main forest types to climatic anomalies across Croatian biogeographic regions inferred from FAPAR remote sensing data

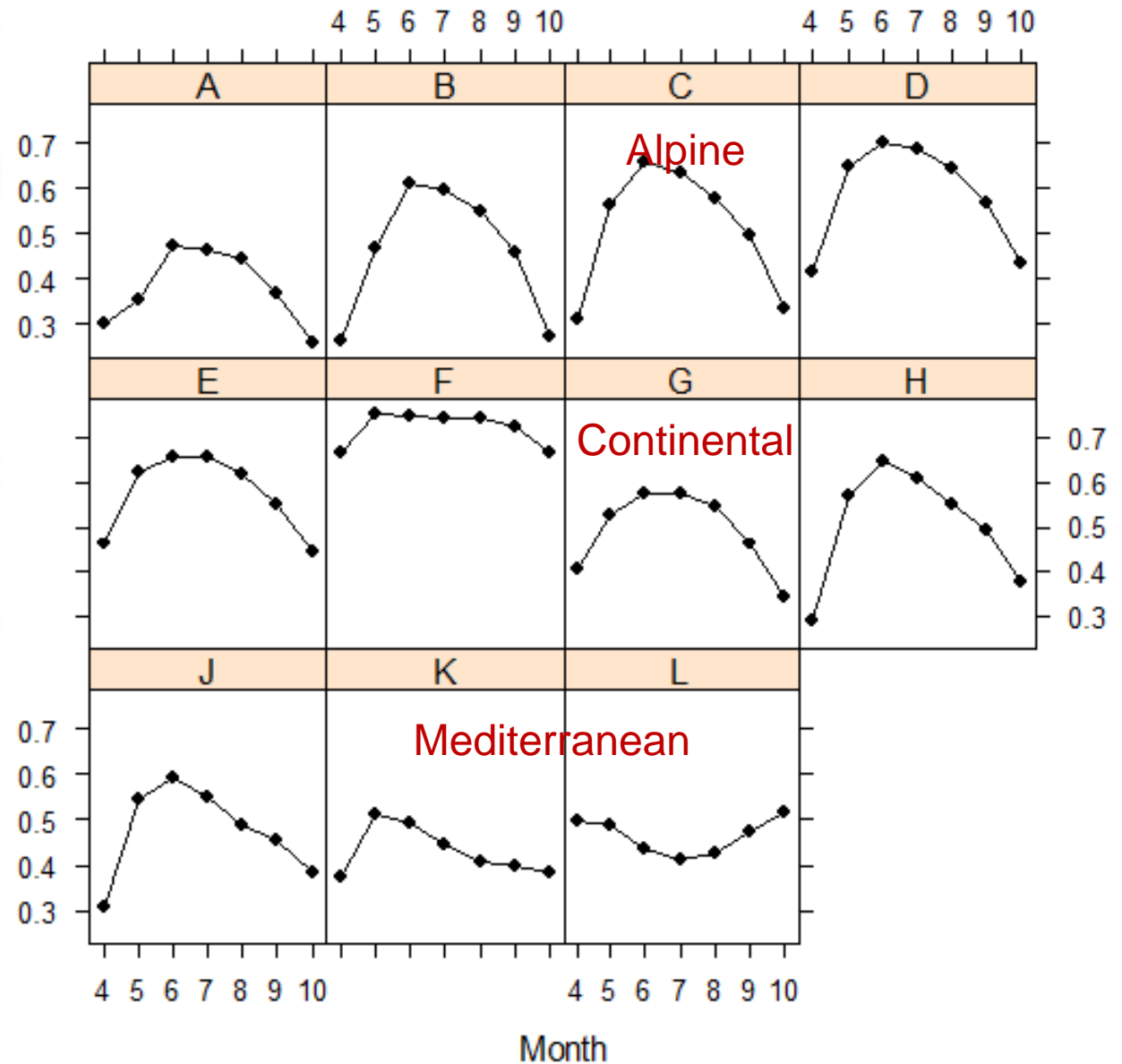
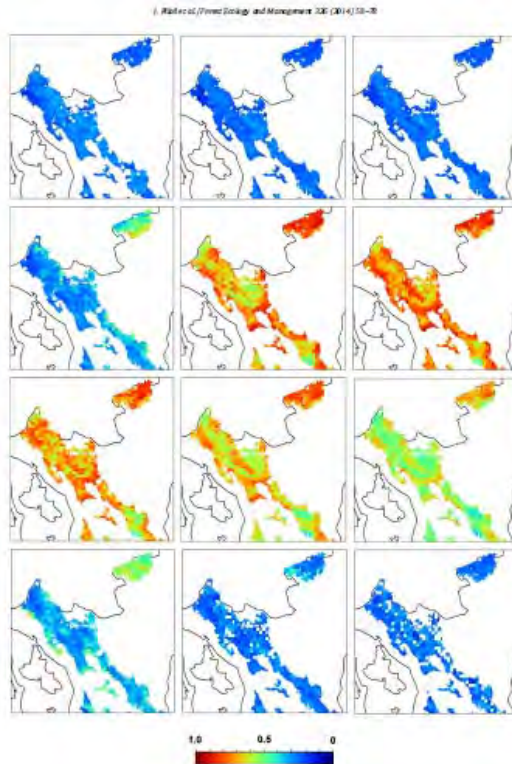
Ivan Pilaš^{a,*}, Ivan Medved^b, Jasna Medak^a, Damir Medak^b

^a Croatian Forest Research Institute, Division of Ecology, Cvjetno naselje 41, 10450 Jastrebarsko, Croatia

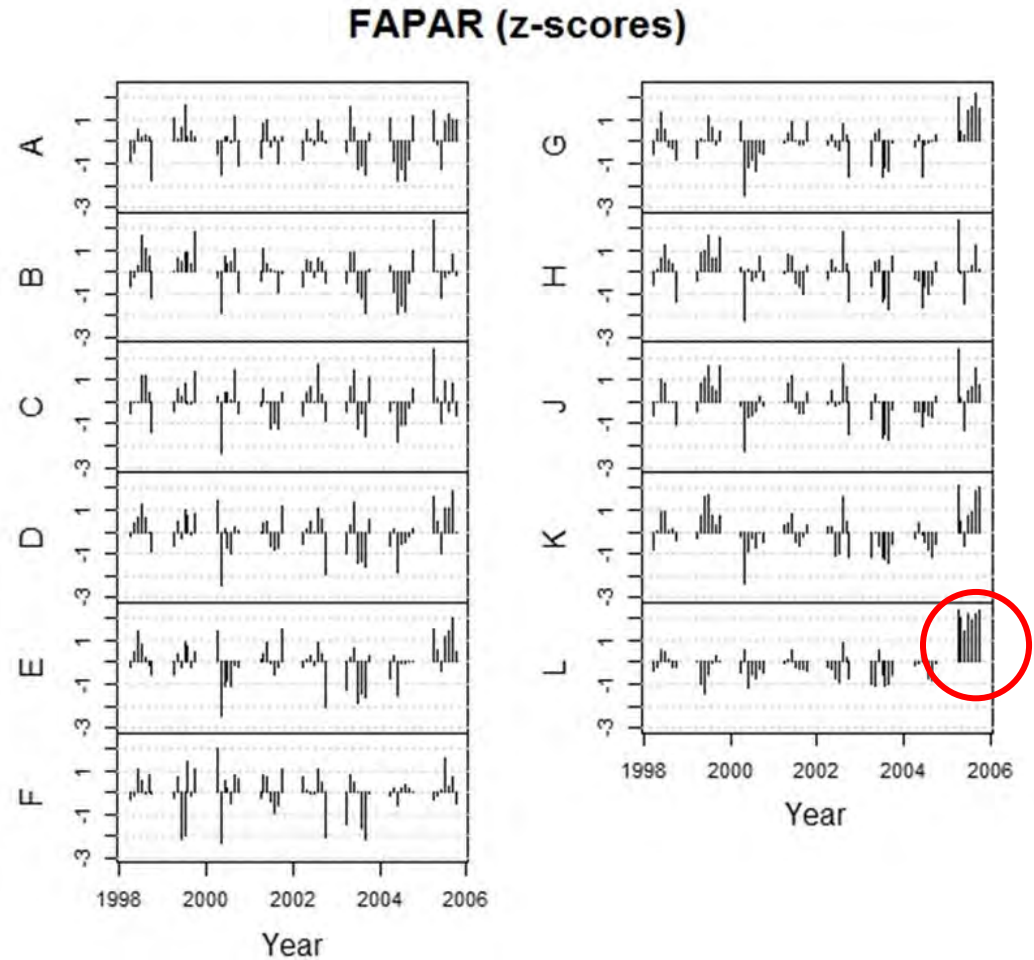
^b Department of Geoinformation Science, University of Zagreb, Faculty of Geodesy, Kačićeva 26, 10001 Zagreb, Croatia



Monthly mean FAPAR (MMF)

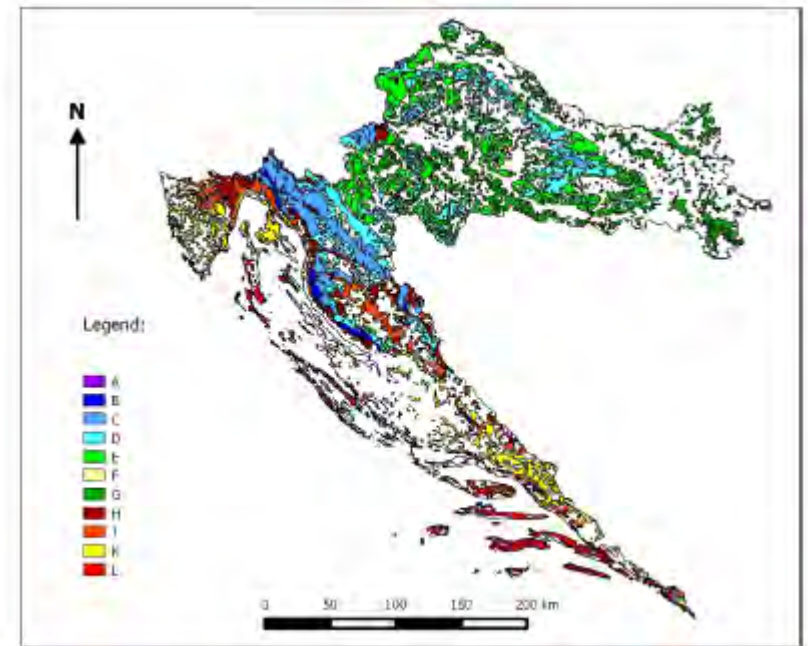
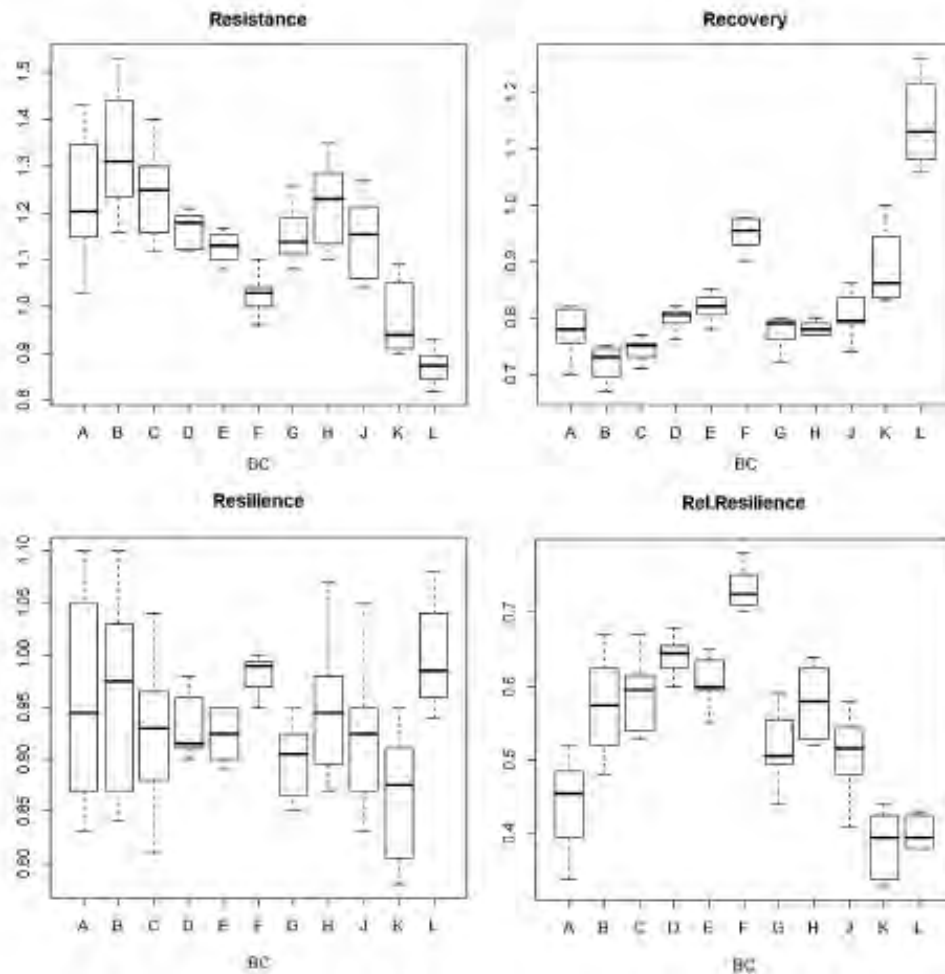


Mediterranean trees show higher NWR potential and better water conservation, they are not limited to growing season!



Inherent WR of forests as resilience strategy

L. Piliš et al. / Forest Ecology and Management 326 (2014) 58–78



Thank you!