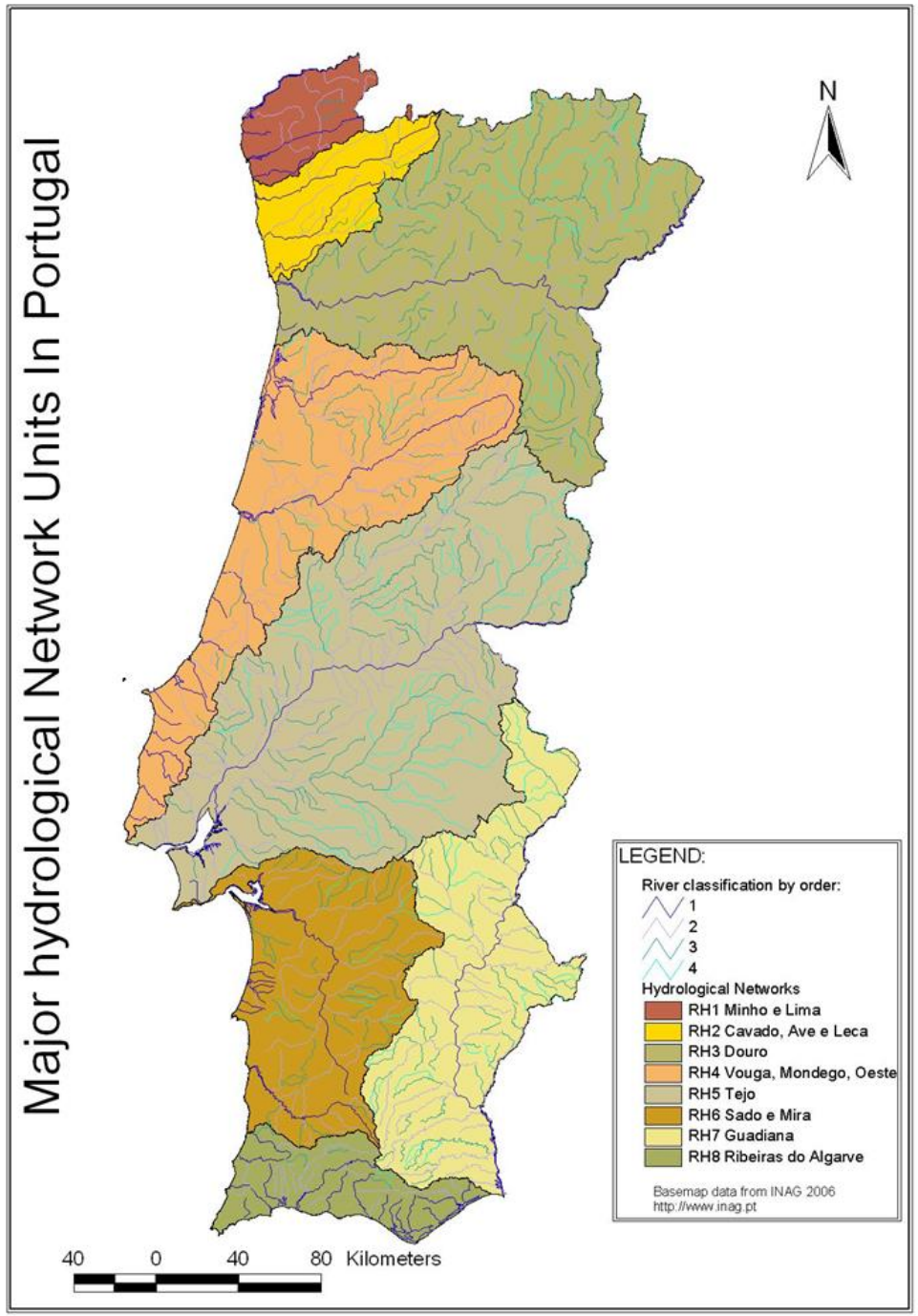
Análise ecológica integrada de cursos de água com recurso a critérios de qualidade físico-química, biológica e habitat

3º colóquio

NO MÉDIO TEJO

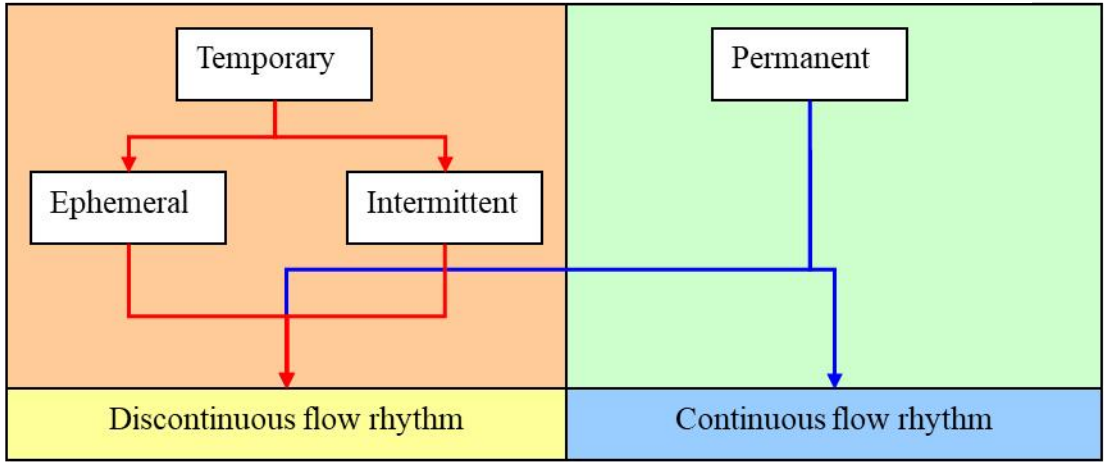
Luís Santos, Luís Quinta-Nova, Sandra Mourato & Gonçalo Marques

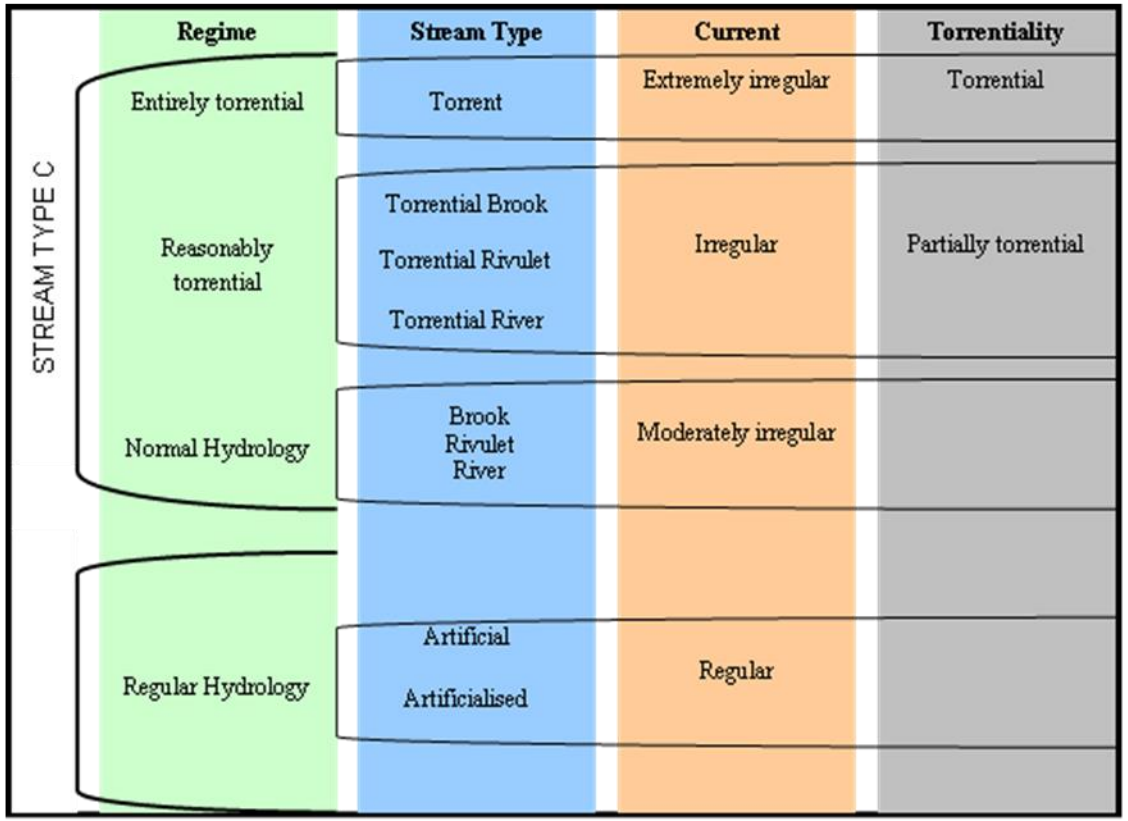


CLIM Risk

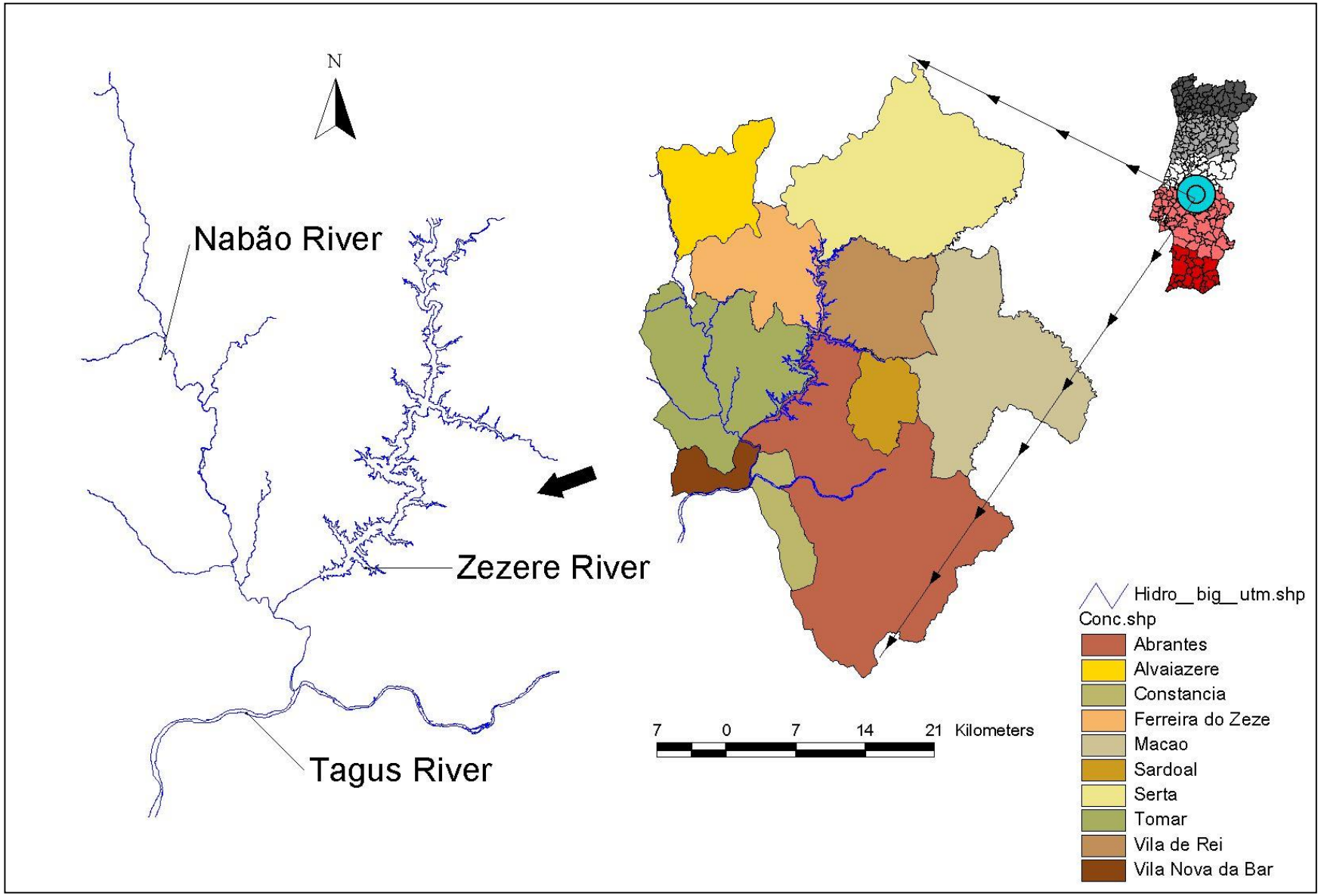
NATRISK

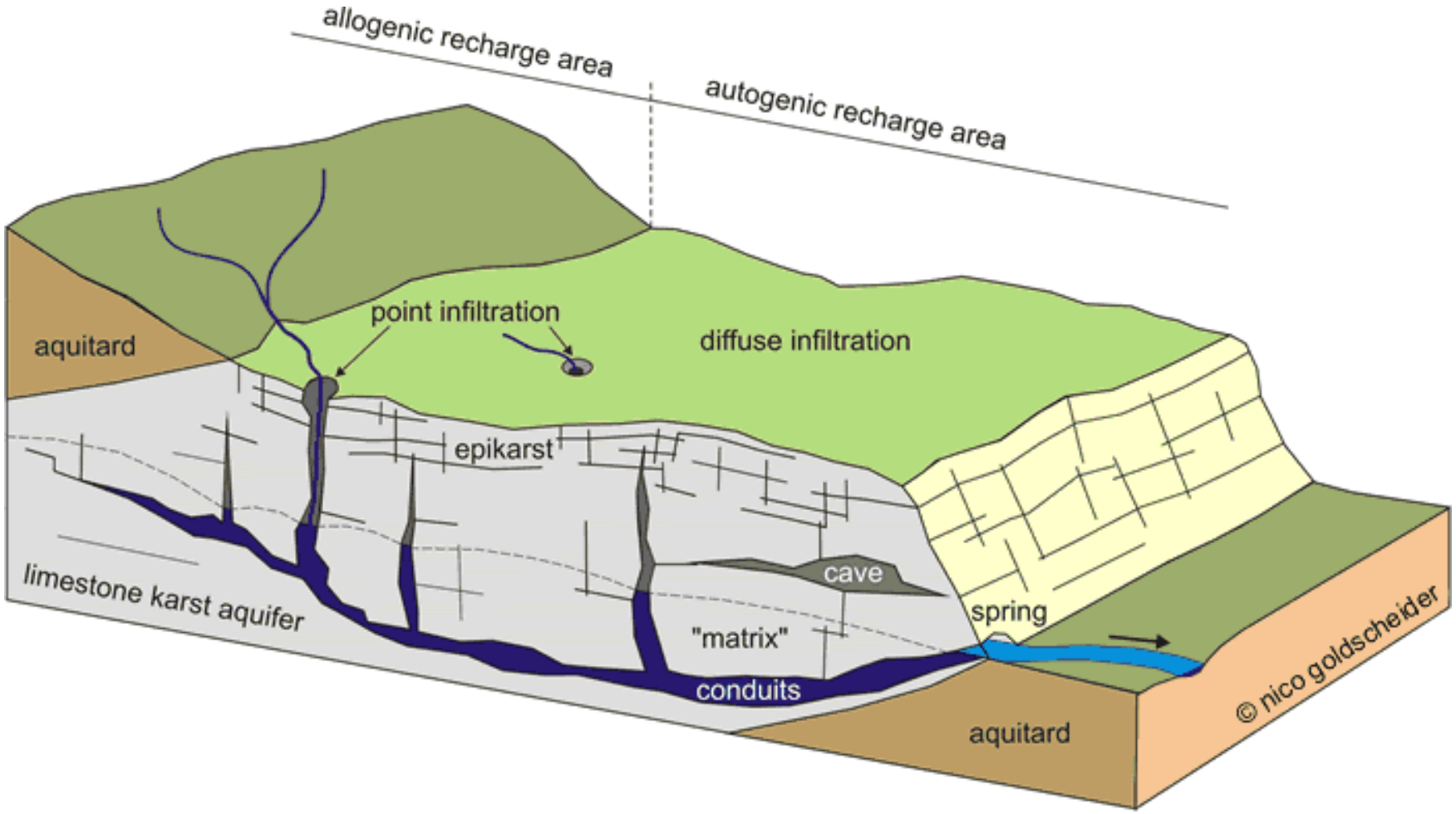
Stream typology



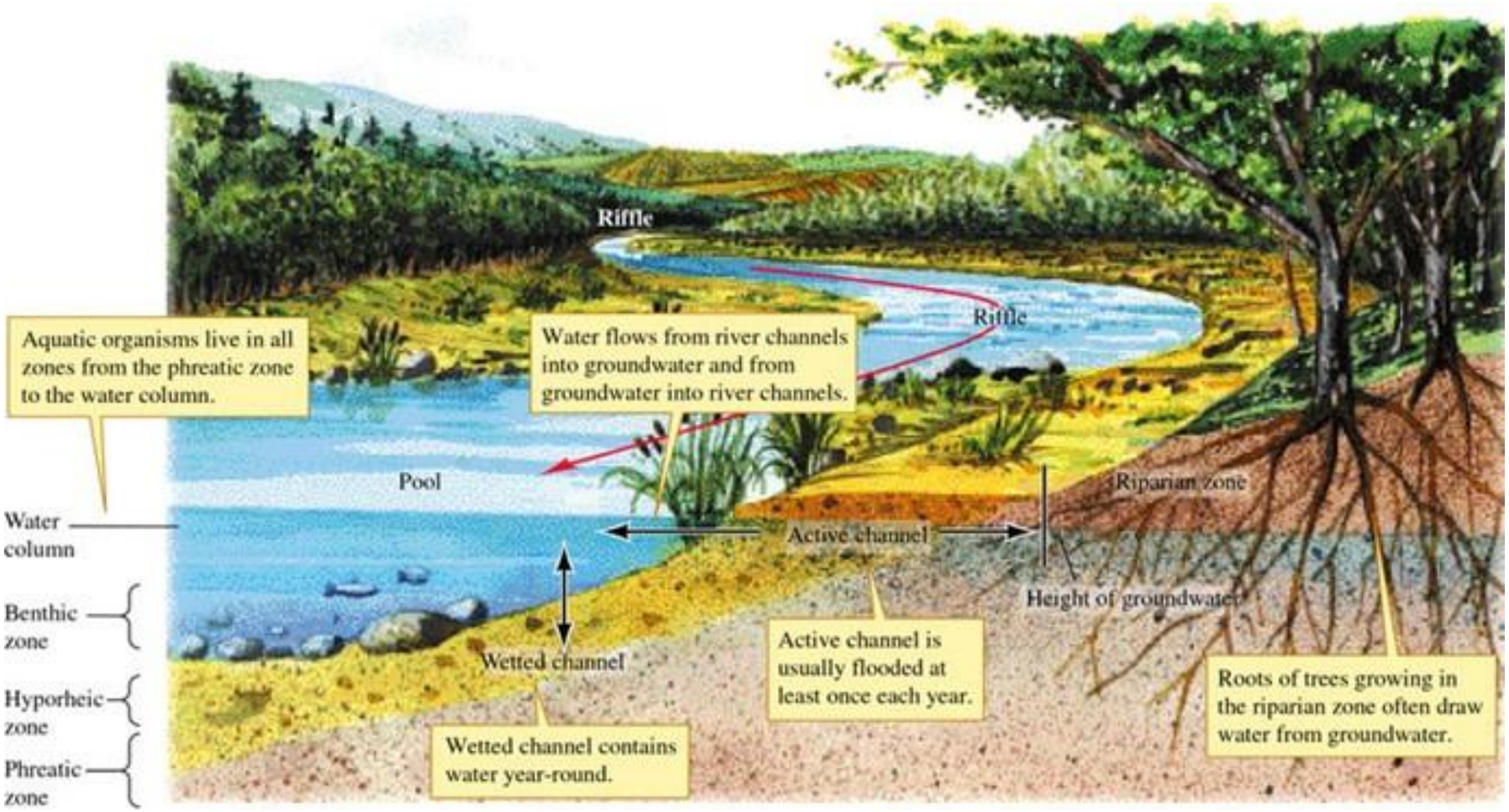


Location of Nabão River



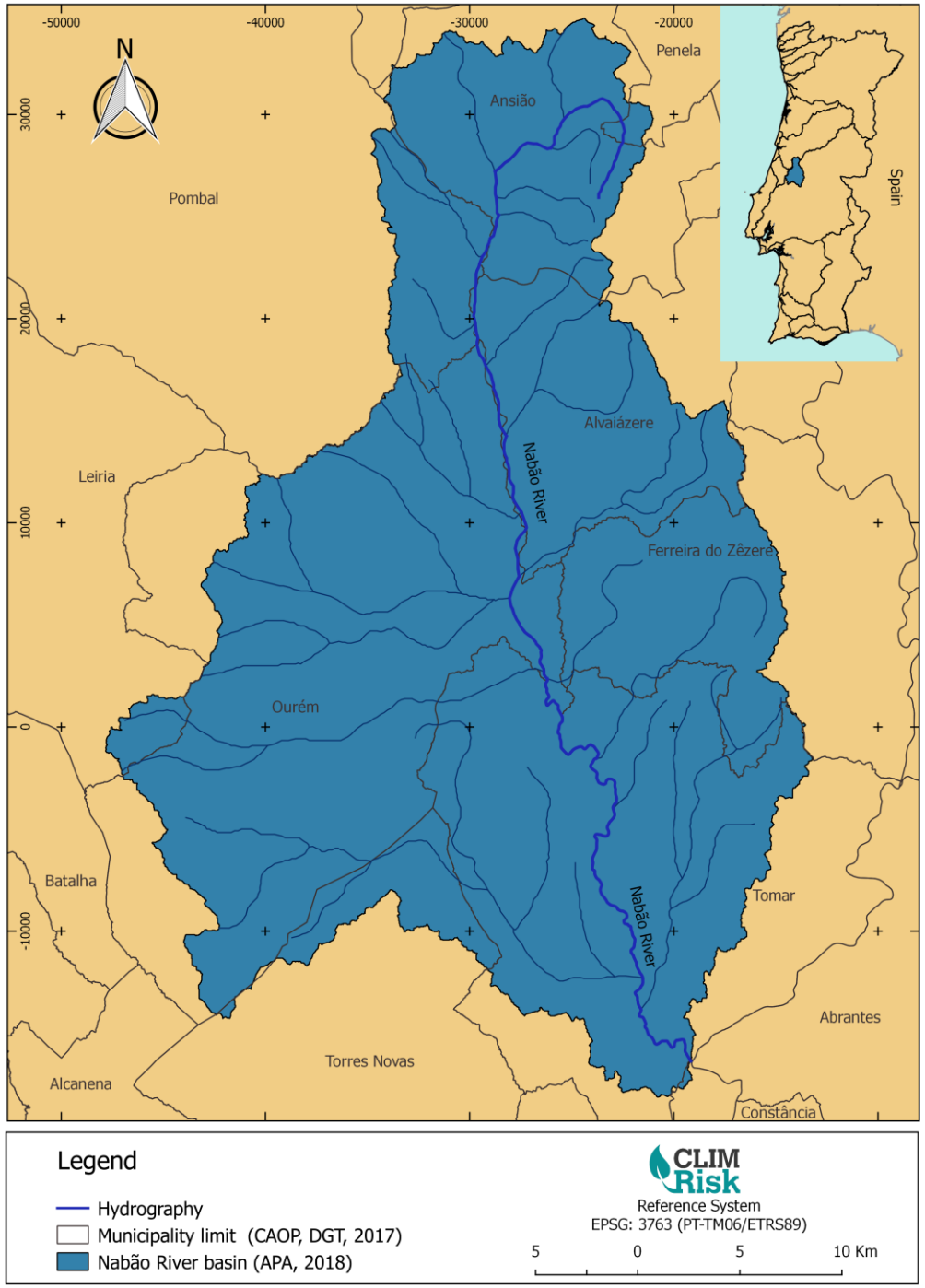


Block diagram of a heterogeneous karst aquifer illustrating the duality of recharge (allogenic vs. autogenic), infiltration (point vs. diffuse) and porosity/flow (conduits vs. matrix) (Goldscheider & Drew 2007).

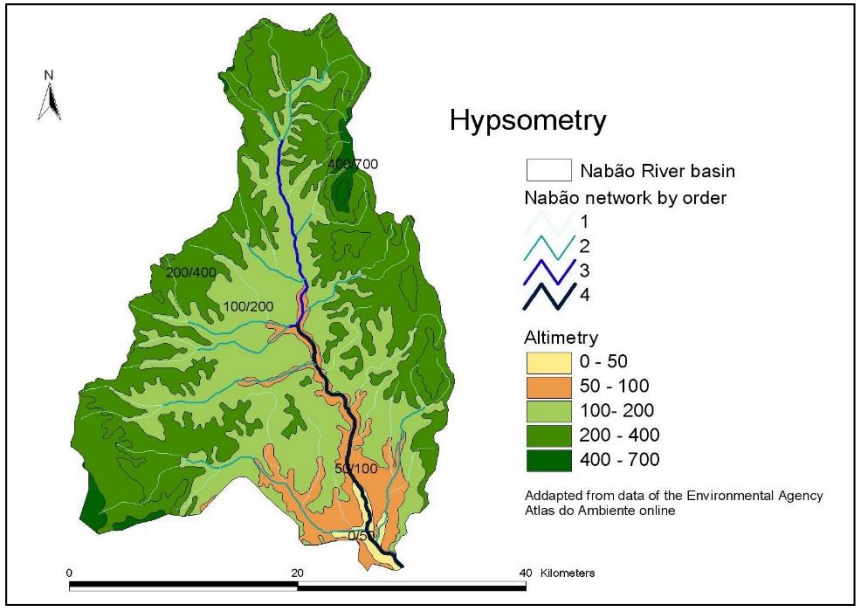


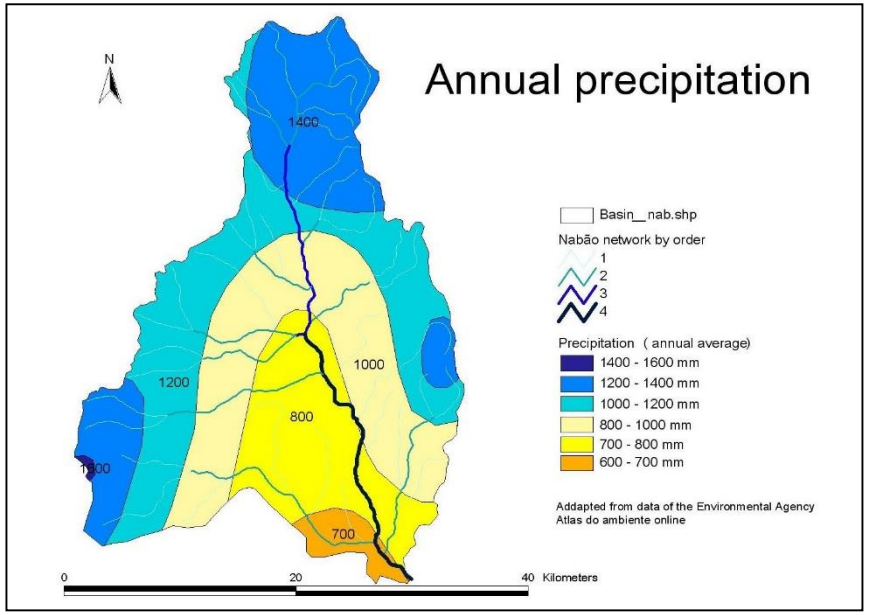
Methods in Stream Ecology - Gary Lamberti F. Richard Hauer

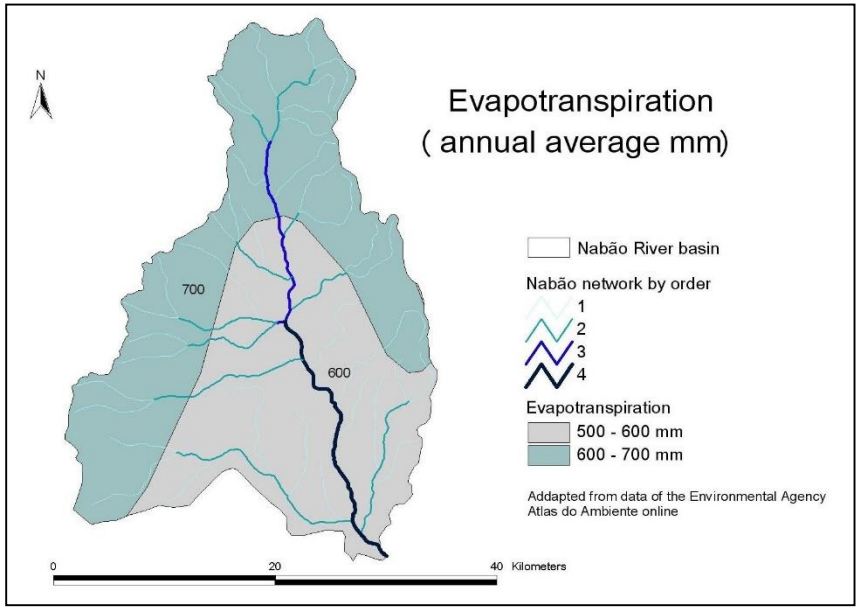
Nabão River basin

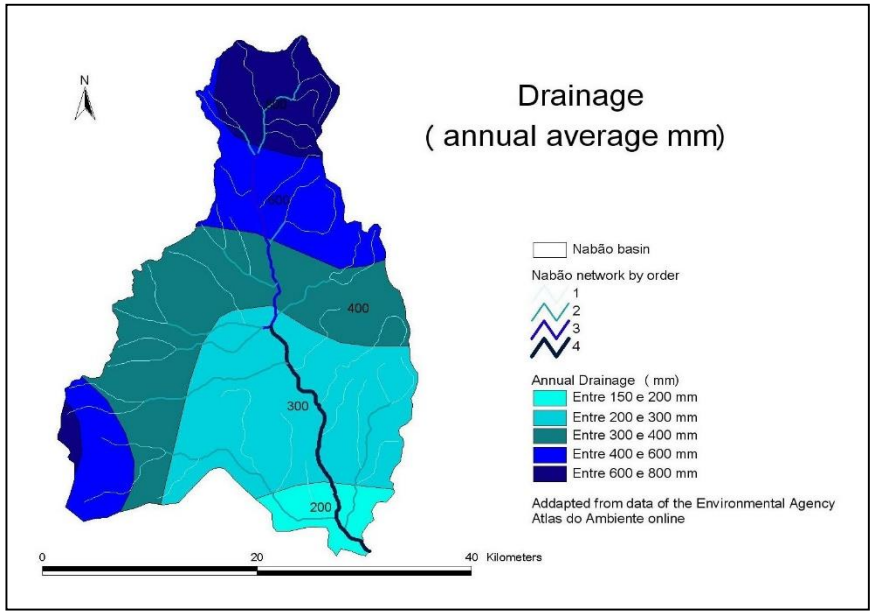


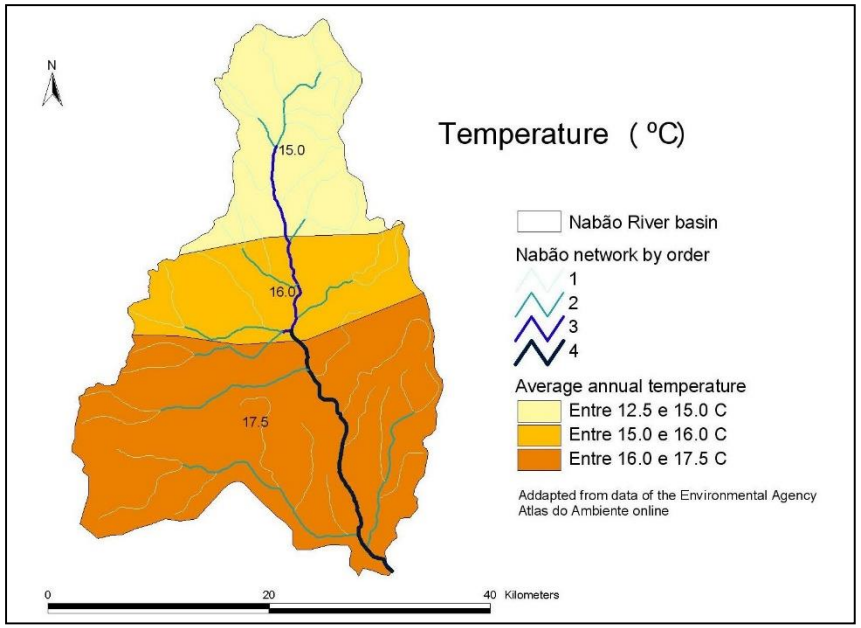
Environmental variables of the Nabão basin

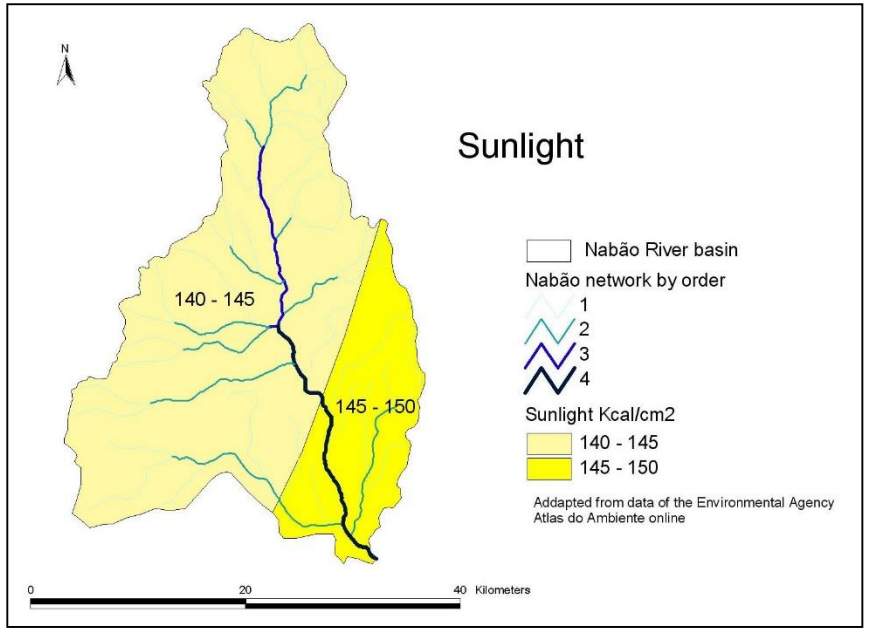


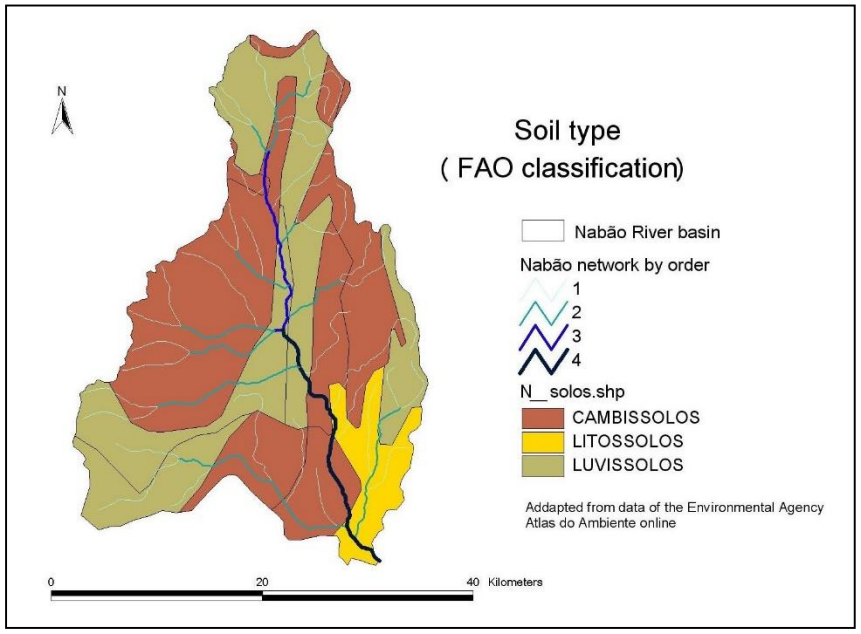


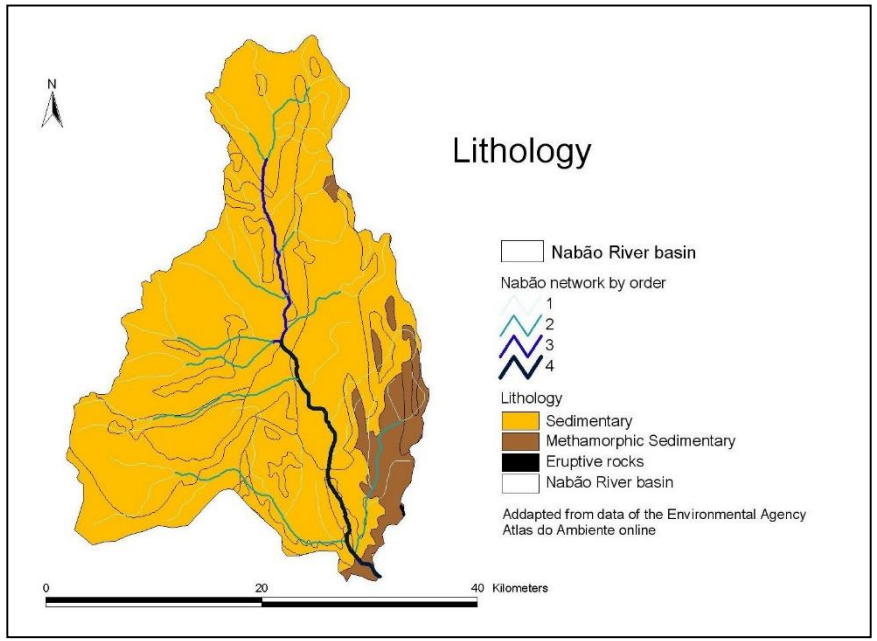












CLIM Risk

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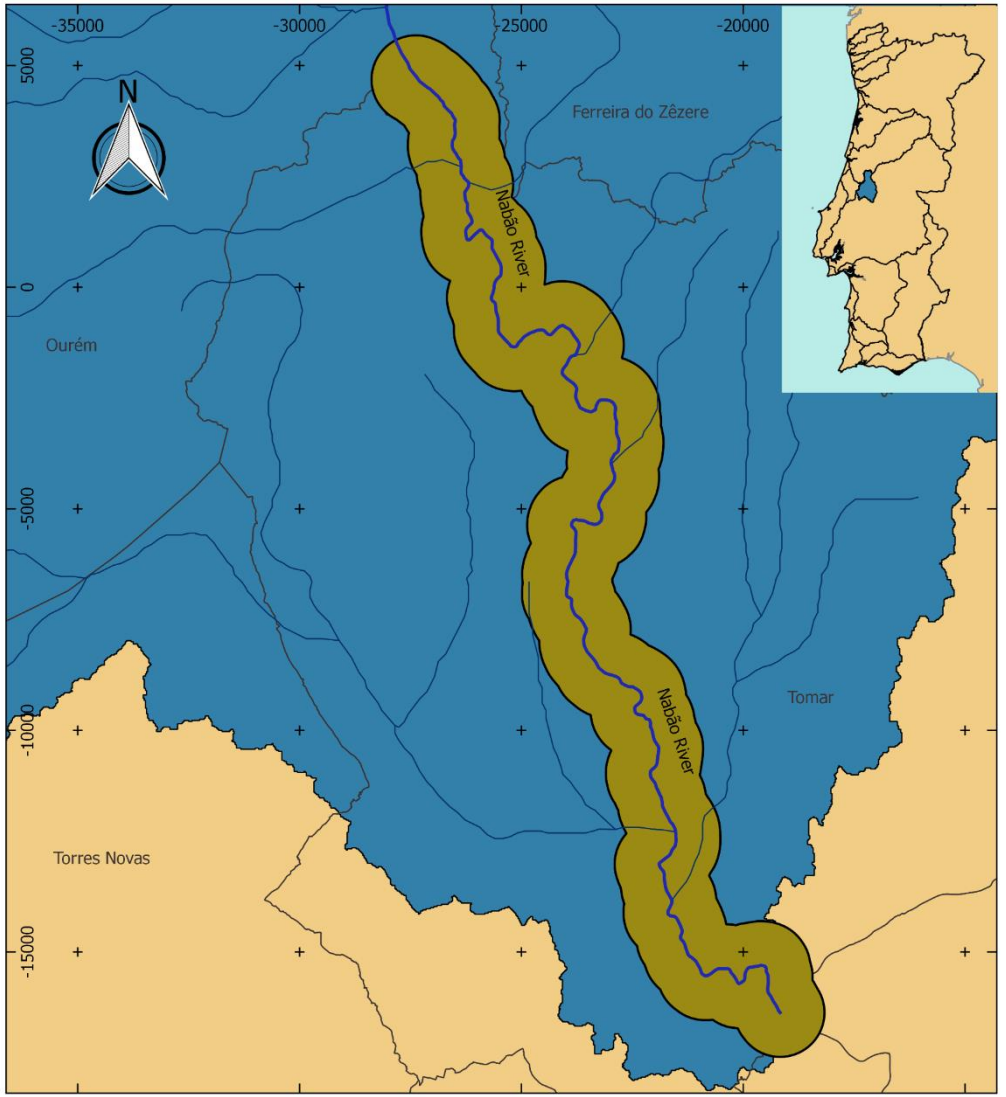
Nabão River basin sampling site selection



Legend

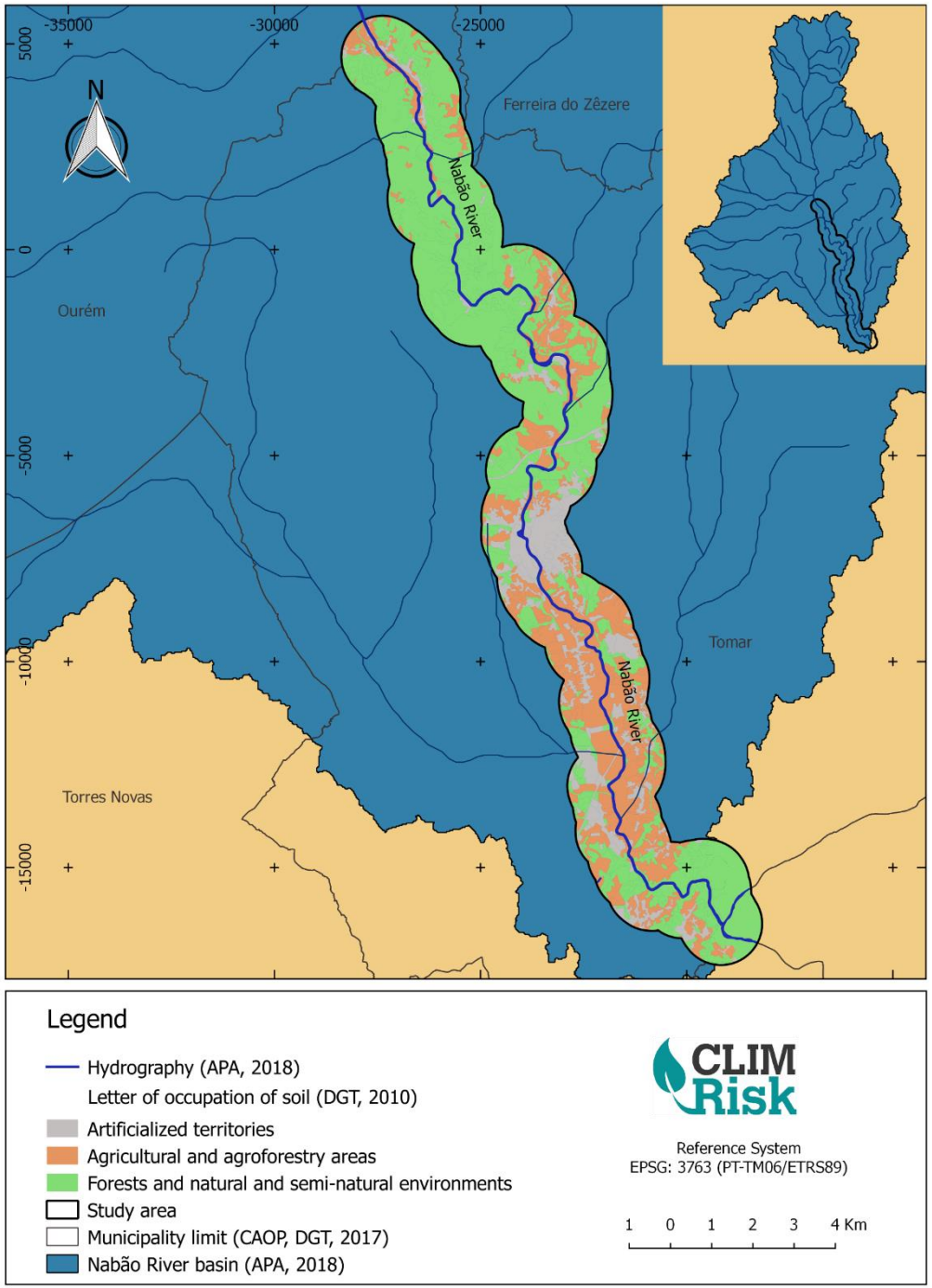
- Hydrography (APA, 2018)
- Study area
- Municipality limit (CAOP, DGT, 2017)
- Nabão River basin (APA, 2018)

CLIM Risk

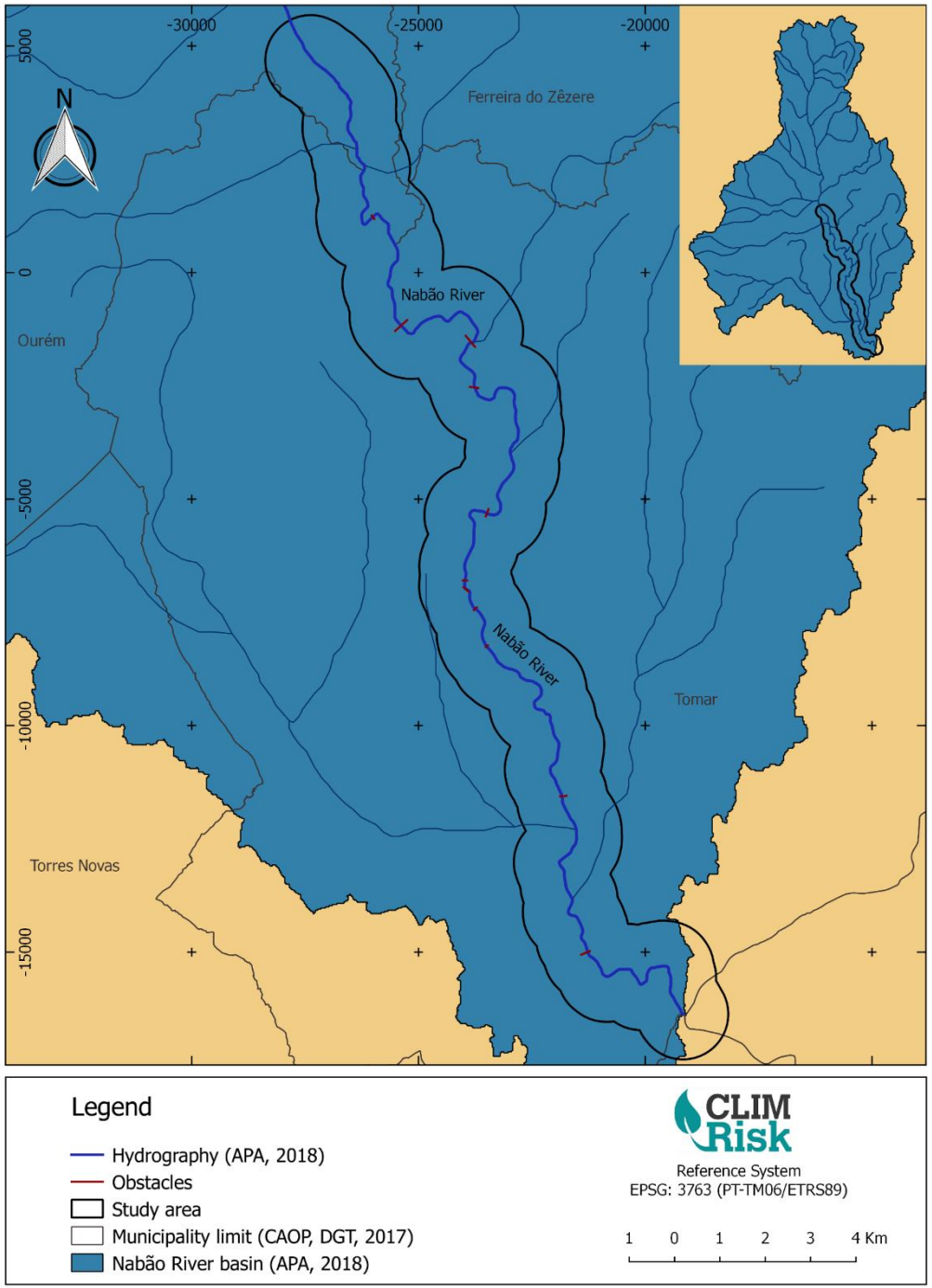
Reference System
EPSG: 3763 (PT-TM06/ETRS89)

1 0 1 2 3 4 Km

Landuse


-35000
-30000
-25000
5000
0
-5000
-10000
-15000
N
Ferreira do Zêzere
Nabão River
Ourém
Tomar
Nabão River
Torres Novas
Legend
Hydrography (APA, 2018)
Letter of occupation of soil (DGT, 2010)
Artificialized territories
Agricultural and agroforestry areas
Forests and natural and semi-natural environments
Study area
Municipality limit (CAOP, DGT, 2017)
Nabão River basin (APA, 2018)
CLIM Risk
Reference System
EPSG: 3763 (PT-TM06/ETRS89)
1 0 1 2 3 4 Km

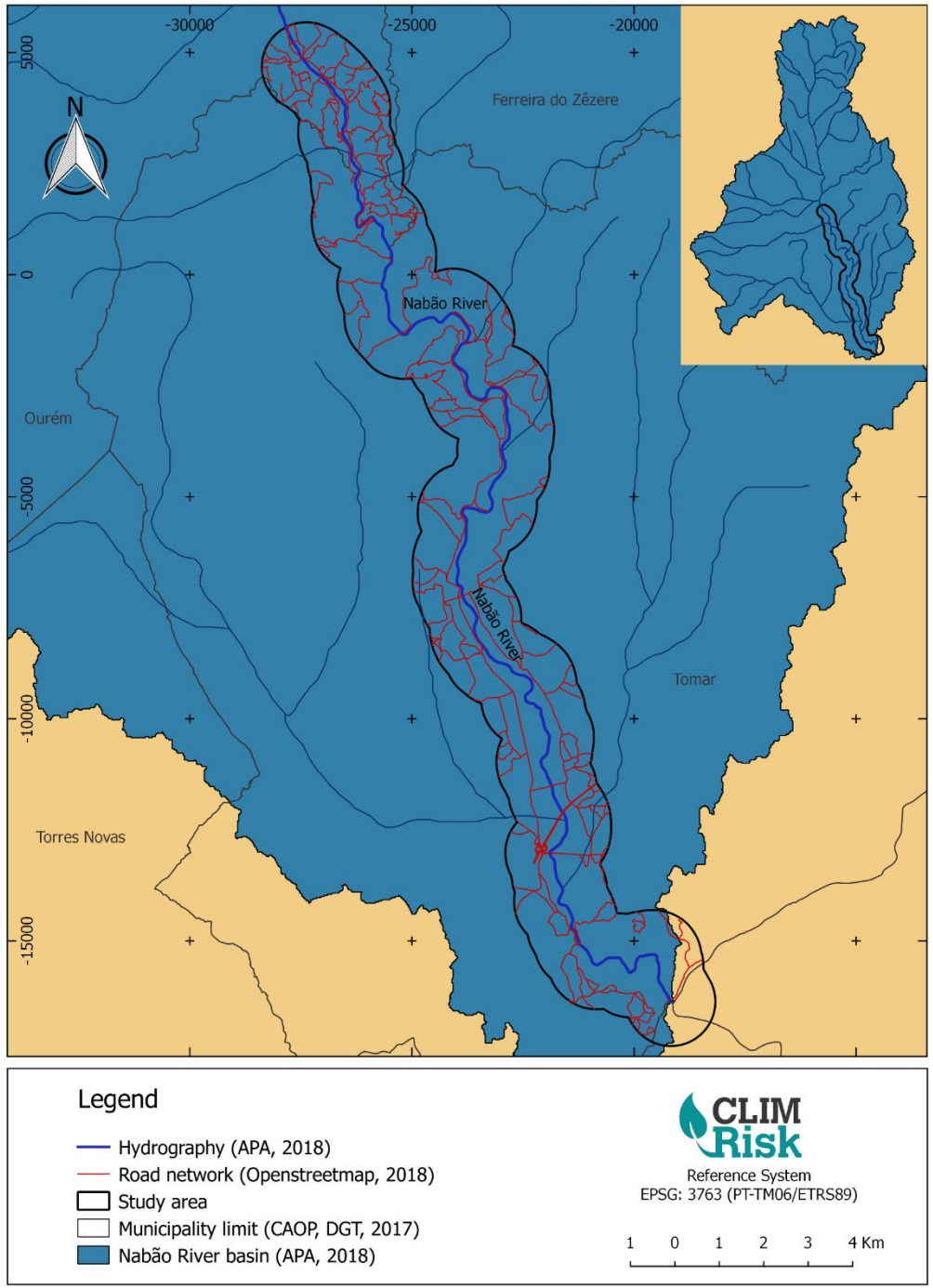
Obstacles



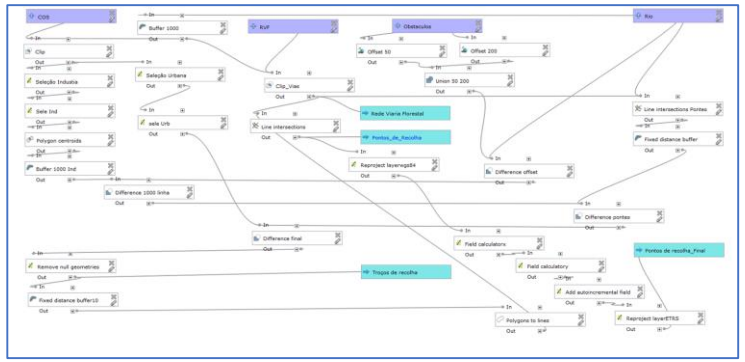
CLIM Risk

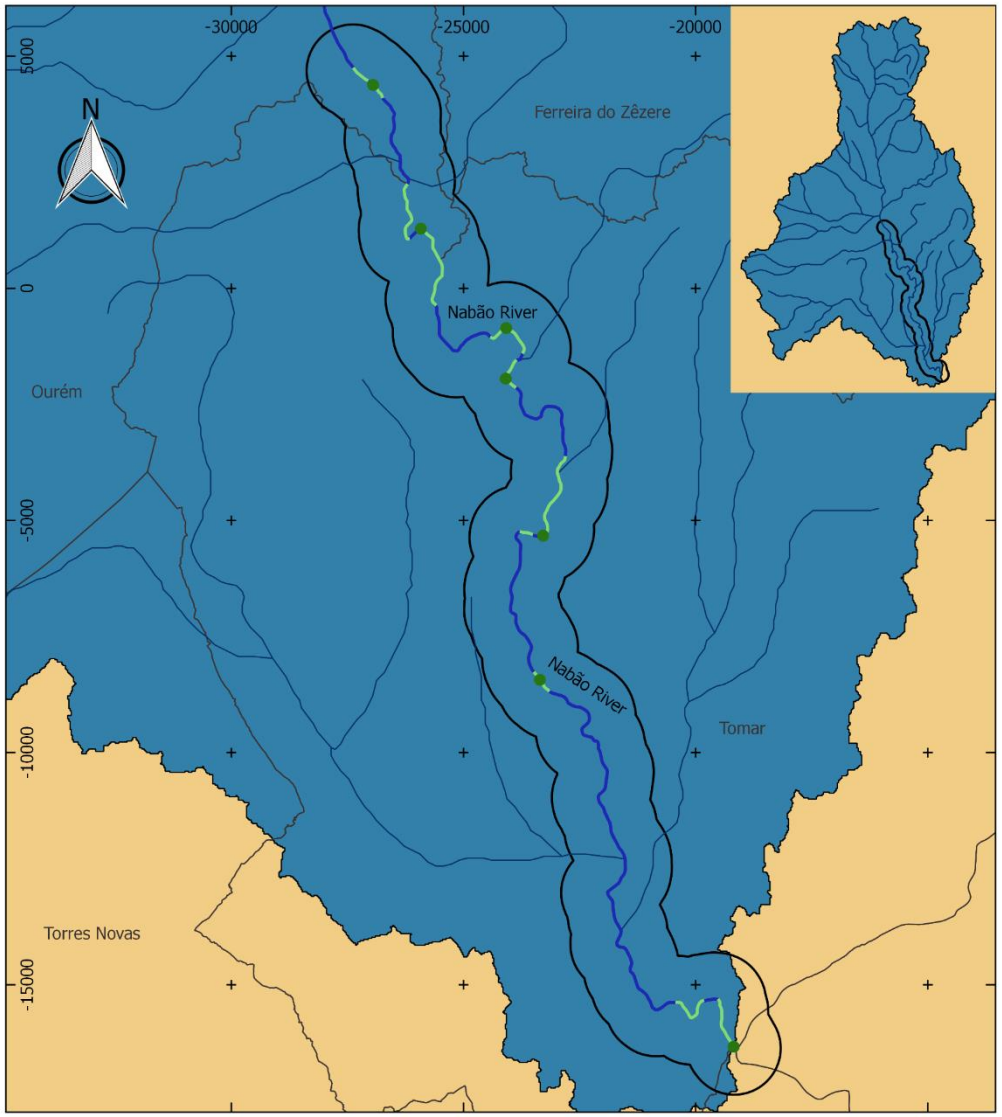
NATRISK

Access


-30000
-25000
-20000
5000
0
-5000
-10000
-15000
N
Ferreira do Zêzere
Nabão River
Nabão River
Ourém
Tomar
Torres Novas
Legend
Hydrography (APA, 2018)
Road network (Openstreetmap, 2018)
Study area
Municipality limit (CAOP, DGT, 2017)
Nabão River basin (APA, 2018)
CLIM Risk
Reference System
EPSG: 3763 (PT-TM06/ETRS89)
1 0 1 2 3 4 Km

QGIS Model





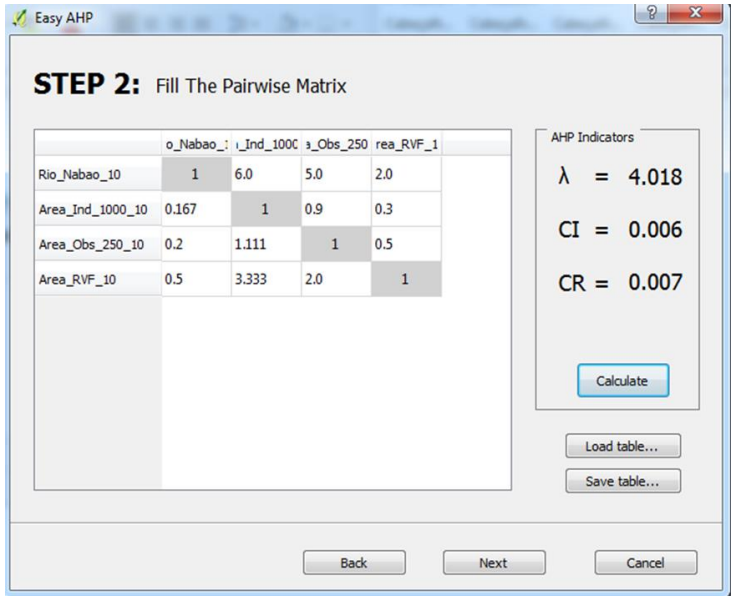
Legend

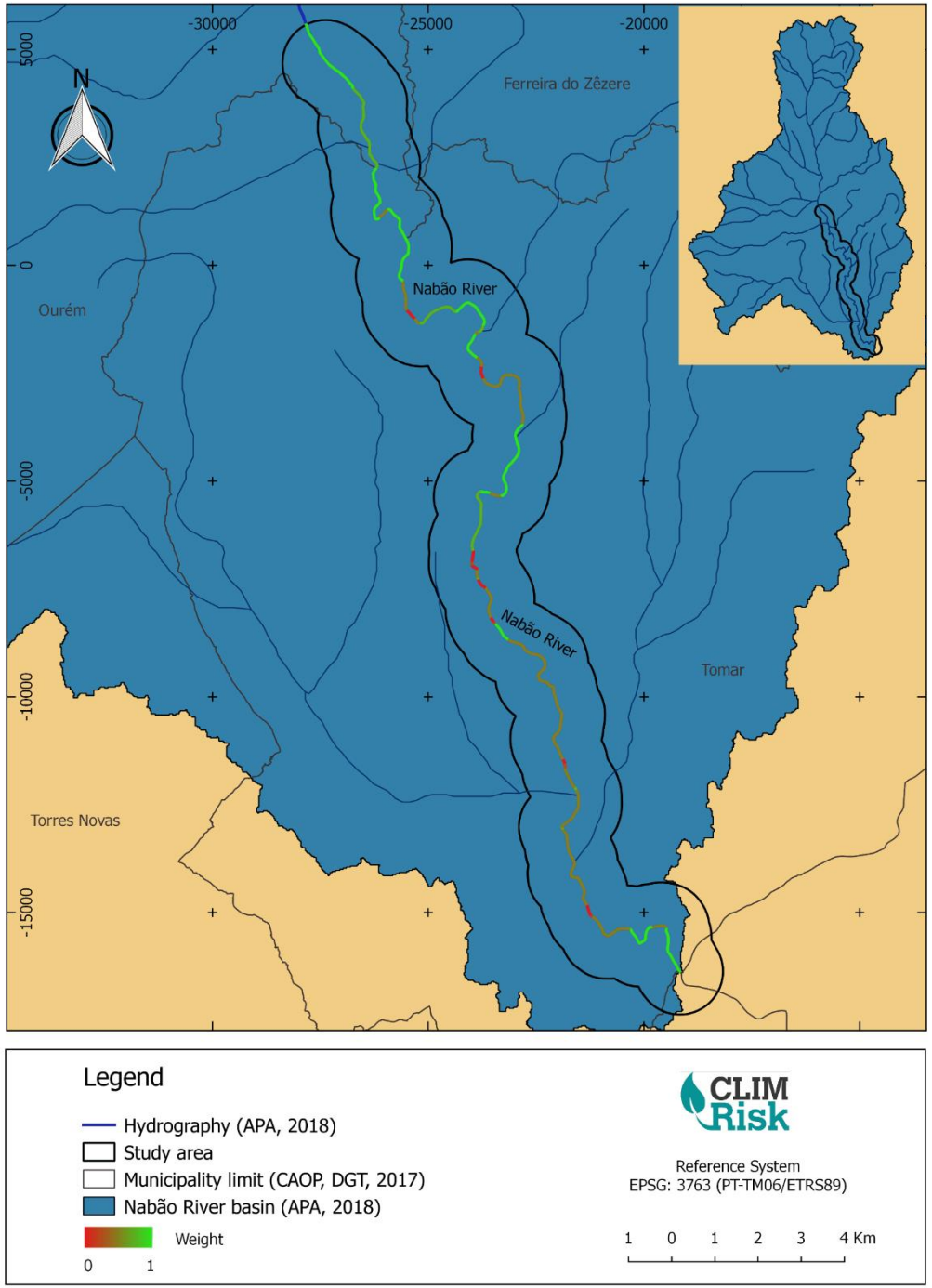
- Collection sites
- Collection sections
- Hydrography (APA, 2018)
- Study area
- Municipality limit (CAOP, DGT, 2017)
- Nabão River basin (APA, 2018)

Reference System
EPSG: 3763 (PT-TM06/ETRS89)

1 0 1 2 3 4 Km

AHP model


Easy AHP
STEP 2: Fill The Pairwise Matrix
o_Nabao_1 ı_Ind_1000 ɜ_Obs_250 rea_RVF_1
Rio_Nabao_10 1 6.0 5.0 2.0
Area_Ind_1000_10 0.167 1 0.9 0.3
Area_Obs_250_10 0.2 1.111 1 0.5
Area_RVF_10 0.5 3.333 2.0 1
AHP Indicators
λ = 4.018
CI = 0.006
CR = 0.007
Calculate
Load table...
Save table...
Back
Next
Cancel


-30000
-25000
-20000
5000
0
-5000
-10000
-15000
N
Ferreira do Zêzere
Nabão River
Ourém
Nabão River
Tomar
Torres Novas
Legend
Hydrography (APA, 2018)
Study area
Municipality limit (CAOP, DGT, 2017)
Nabão River basin (APA, 2018)
Weight
0 1
CLIM Risk
Reference System
EPSG: 3763 (PT-TM06/ETRS89)
1 0 1 2 3 4 Km

Campanhas realizadas - Rio Nabão

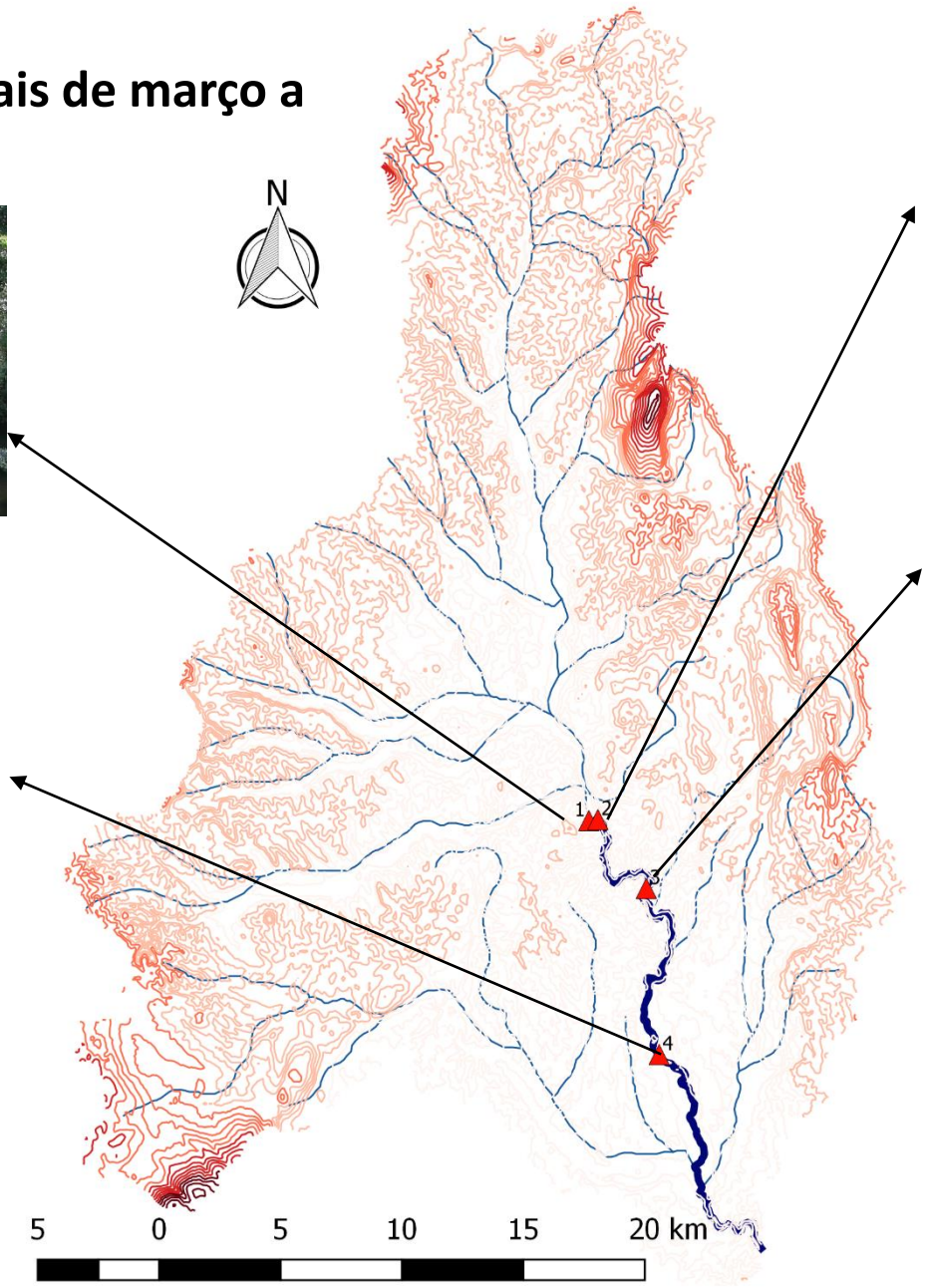
Campanhas mensais de março a setembro de 2018

Site 1

Site 2

Site 3

Site 4



Legenda

pontos_recolha_climrisk

Altimetria

50.0000 - 175.0000

175.0000 - 300.0000

300.0000 - 425.0000

425.0000 - 550.0000

550.0000 - 675.0000

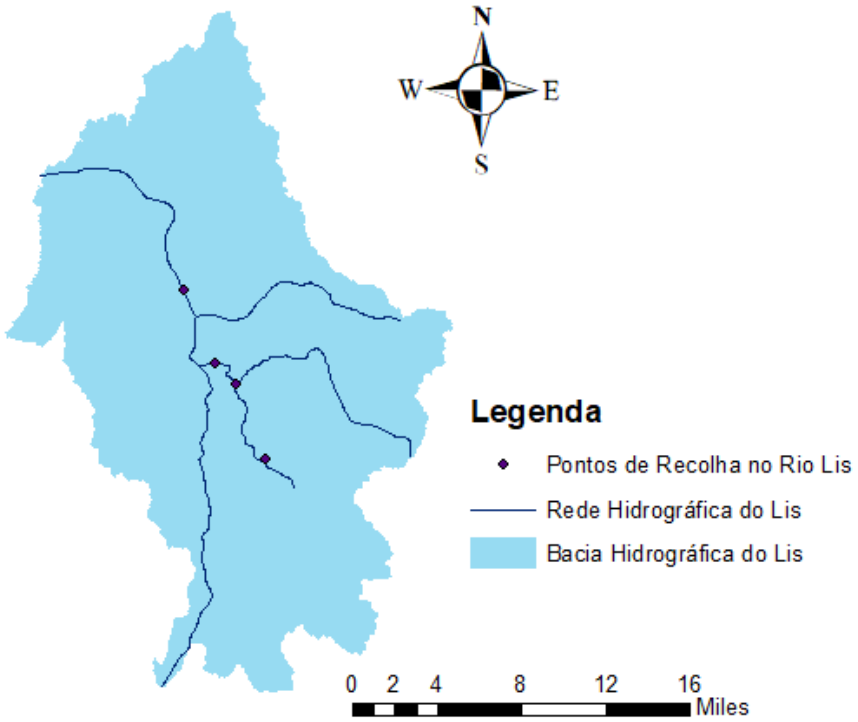
NabaoC

rio_nabão_rede

Campanhas realizadas - Rio Lis

Campanhas no Rio Lis

- Campanhas realizadas no dia 8 de maio de 2018 e no dia 12 de junho de 2018



Monitoring field equipment

- **Multiparametric sensors:**
  - Flow meter;
  - Dissolved solids;
  - Temperature, pH, conductivity and dissolved oxygen;
  - Nitrates Kit;
  - Phosphates Kit;
  - Sectrophotometer;
  - Surber 40Cm sampling area - 500µm mesh.

The choice of Macroinvertebrates:

- Sedentary behaviour, allowing the precise pinpointing of pollution sources;
- Relatively long life-cycles, enabling the study of temporal variations and the impact of exposure to intermittent or prolonged pollutants.
- Easily quantifiable, with well developed methodological approaches;
- Inexpensive sampling equipment, and of reasonably easy usage;
- Easily identifiable to family level;
- Large variety of data analysis methodologies, including biotic and diversity indexes;

- Besides the bioindicator role, macroinvertebrates represent an important function in the ecosystem's energy transfer, being represented in various trophic levels with different feeding behaviours;

- Colonise a wide variety of materials in streams, interstitial spaces, rocks, macrophytes, periphiton, roots and submerged plant material;

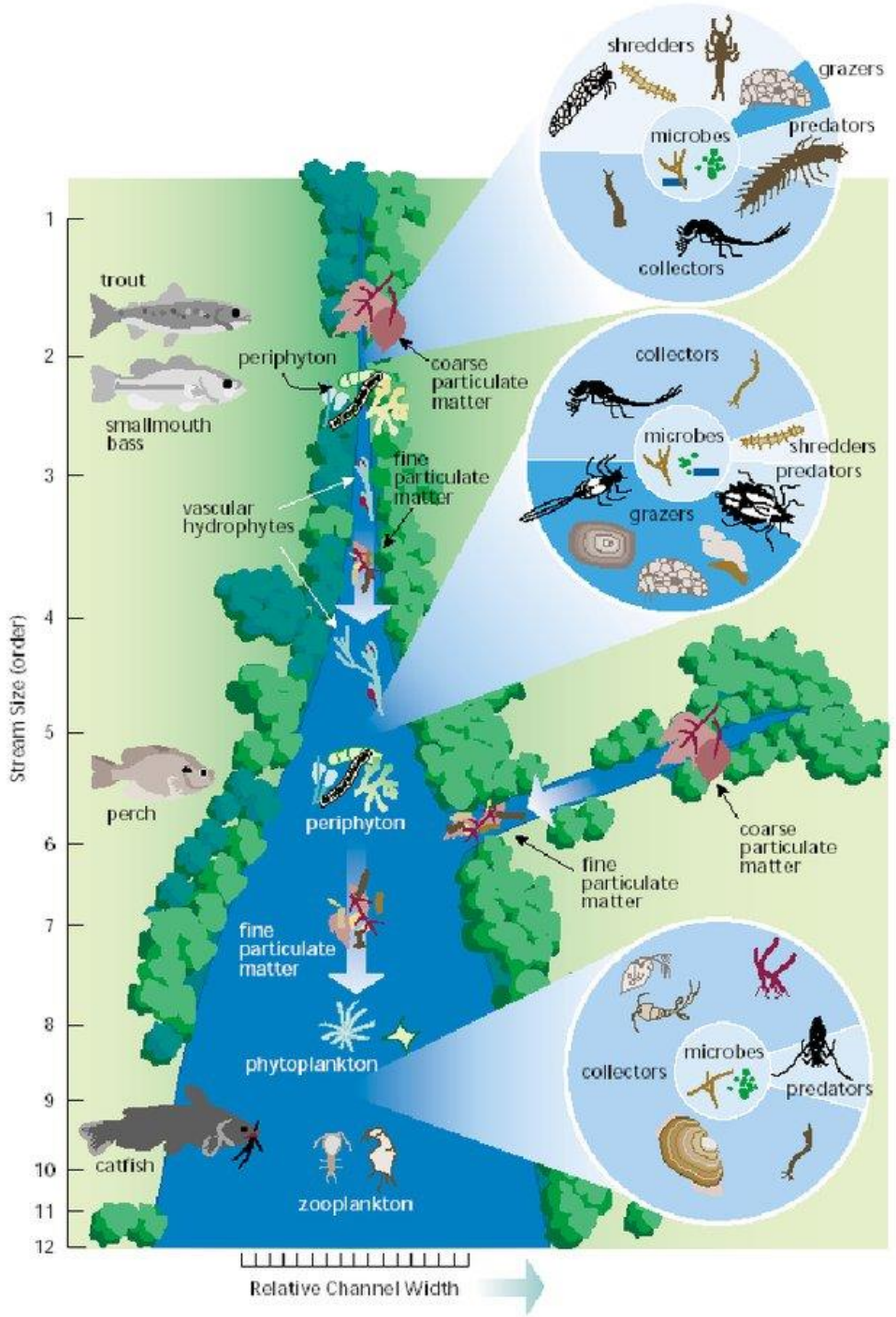
- Form diversified communities;

- Generally abundant;

- Species respond distinctively to different pollutants;

- Communities are formed by heterogeneous groups, allowing different responses;

- Strongly related to habitat composition.



The river continuum concept by Vannote et al. 1980. The proportion of invertebrate feeding groups corresponds to changes in the physical factors in the longitudinal direction (Figure taken from USDA)

Sampling fieldwork:

Ponto de amostragem	Profundidade média (cm)	Largura do troço (m)	Velocidade (m/s)	Amostra	Tipo de corrente	Tipo de habitat	Hora recolha
A	E D 38,5 9 38	4,05		1	Lótico	Calcário 100%; calhaus 20cm ∅	10:50
				2		Calhaus 10/20cm ∅; zona mais profunda	11:00
				3		Raízes de árvores	11:05
B	23 44 34	7,10		1	Lótico	Margem pouco profunda	12:30
				2		Seixo rolado 10/20cm; calcário 90%	12:38
				3		Fundo rochoso na margem direita; zona profunda	12:45
C	56 22 37	8,8		1	Lótico	Areia e canas na margem direita	14:00
				2		Seixo rolado 20/30cm; quartzito 40%	14:08
				3		Seixo rolado 20/30cm; quartzito 40%; margem esquerda mais profunda	14:15
D	41 36 31	14		1	Lótico	Centro leito do rio; seixo rolado 5cm com areia	16:10
				2		Margem direita; rochas 40cm e areia	16:15
				3		-	-

Macroinvertebrate sampling results

- 82 Families of all functional feeding groups;
- Analysis of BMWP' Modified
- ASPT analysis

	Fam | Site	March_1			March_2			March_3			March_4		
10	Heptageniidae	1	0	0	0	4	0	0	0	0	0	0	0
10	Potamanthidae	1	0	0	0	0	0	0	0	0	0	0	0
10	Ephemeridae	0	0	0	0	0	0	0	0	0	0	1	1
10	Perlodidae	0	0	1	4	4	2	0	0	0	0	0	0
10	Odontoceridae	0	0	0	0	0	0	0	0	0	0	0	0
10	Helicopsychidae	0	0	1	0	0	0	0	0	0	0	0	0
8	Gomphidae	4	0	2	0	0	0	0	0	0	0	0	0
8	Libellulidae	0	0	0	0	0	0	0	0	0	0	0	0
8	Psychomyiidae	0	0	0	0	0	0	0	0	0	0	0	0
8	Philoptamidae	0	0	0	0	0	0	0	0	0	0	0	0
8	Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0
7	*Ephemerellidae*	0	0	1	1	3	4	3	0	0	0	0	0
7	Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0
7	Limnephelidae	0	0	0	0	0	0	0	0	0	0	0	0
7	Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	0
6	Neritidae	0	0	0	4	1	1	0	0	0	0	0	0
6	Ancylidae	1	1	0	0	0	0	0	0	0	0	0	0
6	Unionidae	3	1	2	0	1	1	0	0	0	0	0	0
6	Hyriidae	0	0	0	0	0	0	0	0	0	0	0	0
6	Gammaridae	1	1	23	14	13	22	4	3	3	0	0	0

Flow results for Lis River

Ponto de amostragem	Campanha 1	Campanha 2
A (Fontes)	0,346 m^3/s	0,209 m^3/s
B (Parque radical)	1,972 m^3/s	1,645 m^3/s
C (Açude do Arrabalde)	2,024 m^3/s	-
D (Campos do Lis)	3,024 m^3/s	4,165 m^3/s

Water quality results - Lis

		1ª Campanha	2ª Campanha	
Ponto de Amostragem	Parâmetros Físico-Químicos	Sondas multiparamétricas	Sondas multiparamétricas	Unidades
A	pH	7,8	8,24	
	Temperatura	16	16,3	°C
	Condutividade	521	610	µS/cm
	Oxigénio Dissolvido	7,13	7,03	mg/L
	Turvação	0	0	NTU
	Sólidos Dissolvidos Totais	-	-	mg/L
	Salinidade	-	-	g/kg
B	pH	9,22	9,66	
	Temperatura	15,84	16,54	°C
	Condutividade	640	648	µS/cm
	Oxigénio Dissolvido	9,1	9	mg/L
	Turvação	0	0	NTU
	Sólidos Dissolvidos Totais	261	257	mg/L
	Salinidade	-	-	g/kg

Water quality results - Lis

		1ª Campanha	2ª Campanha	
Ponto de Amostragem	Parâmetros Físico-Químicos	Sondas multiparamétricas	Sondas multiparamétricas	Unidades
C	pH	9,93	7,93	
	Temperatura	16,15	17,31	°C
	Condutividade	577	621	µS/cm
	Oxigénio Dissolvido	8,93	8,98	mg/L
	Turvação	0	0	NTU
	Sólidos Dissolvidos Totais	259	245	mg/L
	Salinidade	-	-	g/kg
D	pH	8,25	8,29	
	Temperatura	19,51	17,63	°C
	Condutividade	690	731	µS/cm
	Oxigénio Dissolvido	7,78	8,05	mg/L
	Turvação	0	0	NTU
	Sólidos Dissolvidos Totais	307	307	mg/L
	Salinidade	-	-	g/kg

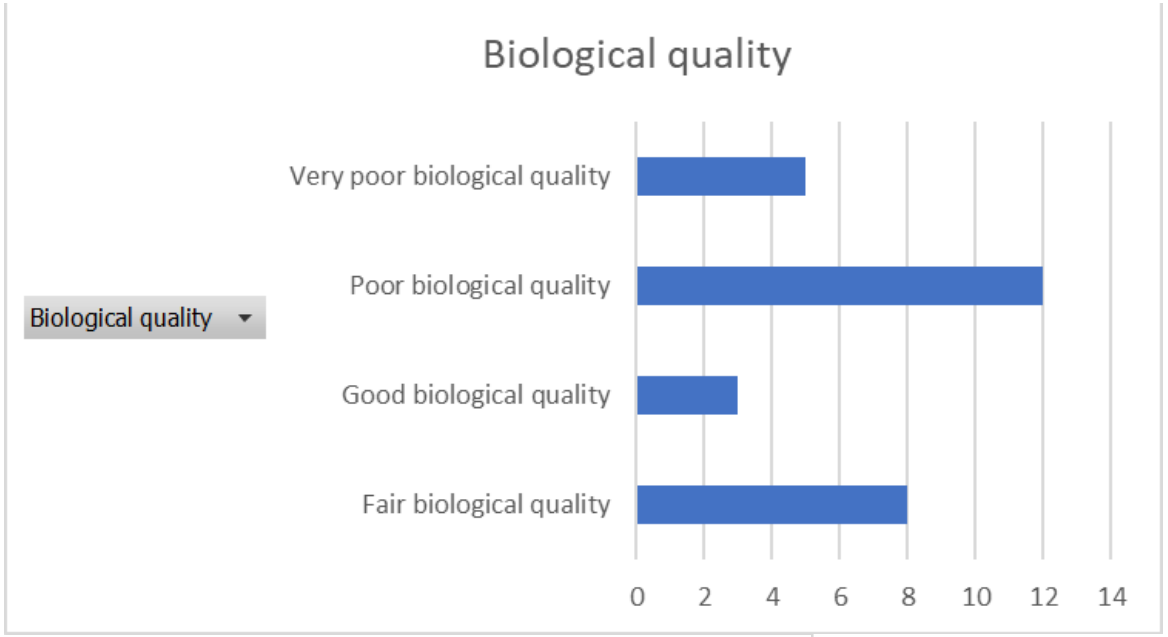
Score analysis – BMWP' Mod. - ASPT

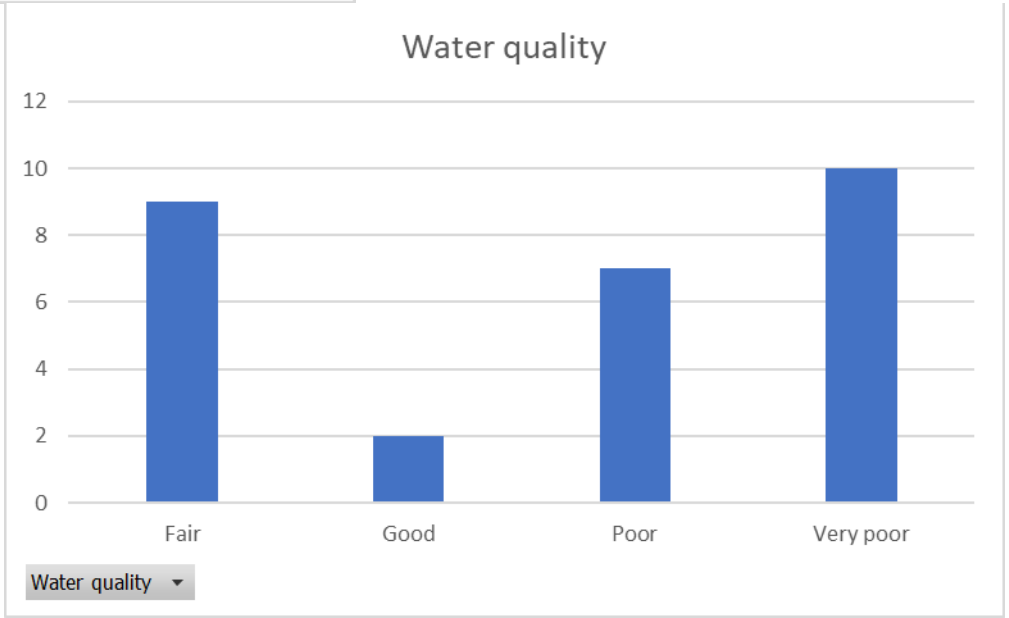
BMWP		ASPT	
BMWP Score	**Biological Quality**	**ASPT**	**Water quality**
Over 130	A. Very good biological quality (natural)	Over 7	Very good (natural)
81 – 130	B. Good biological quality	6.0 – 6.9	Good
51 – 80	C. Fair biological quality	5.0 – 5.9	Fair
11 – 50	D. Poor biological quality	4.0 – 4.9	Poor
0 – 10	E. Very poor biological quality	3.9 or less	Very poor

Biological and Water quality results - Nabão

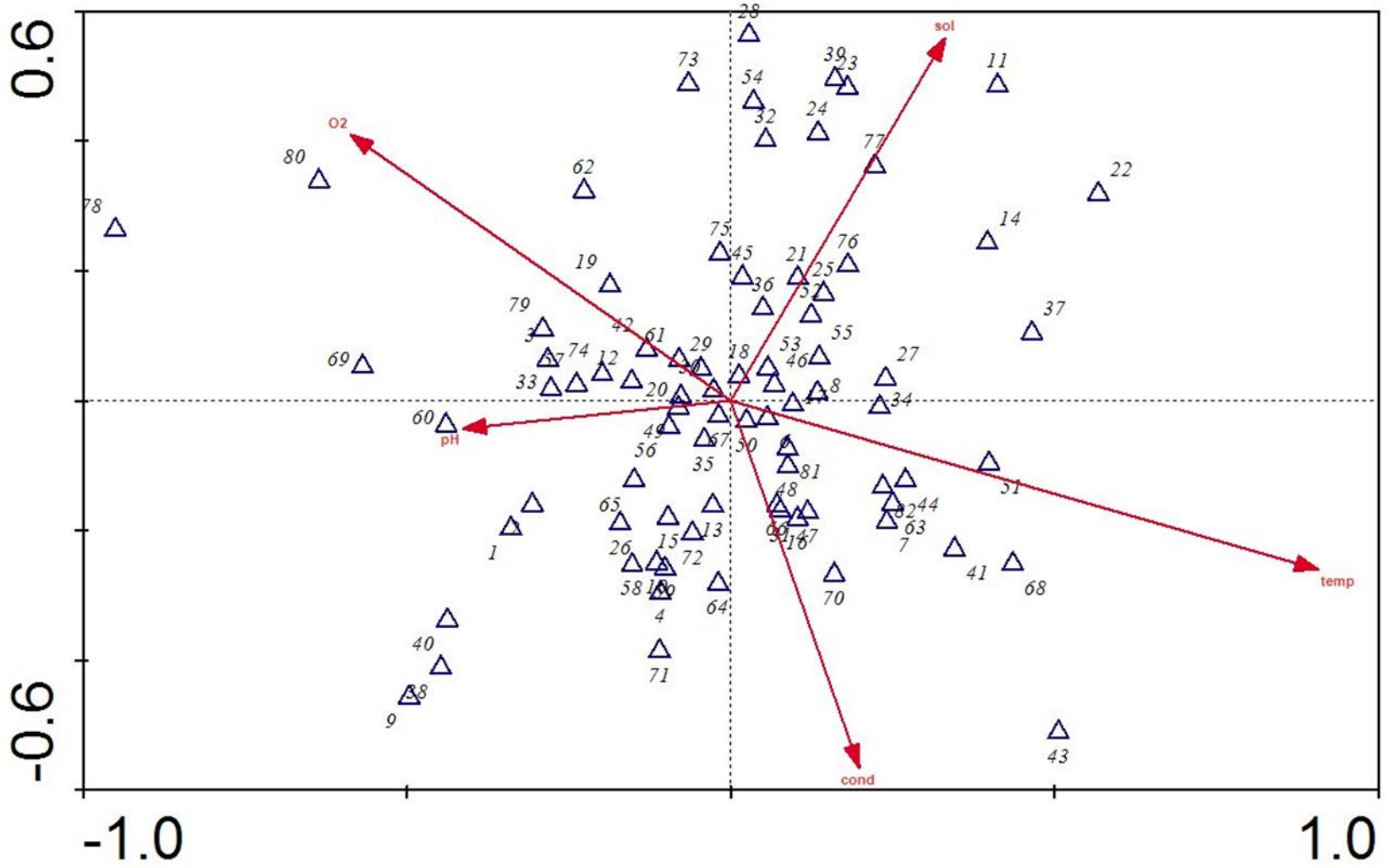
	Nº Ind	Nº Fam	pH	temp	cond	sol	O2	BWMP'	ASPT	Biological quality	Water quality
Mar_1_18	44.7	11.3	7.8	14.0	457.0	109.0	93.0	61.7	5.441176	Fair biological quality	Fair
Mar_2_18	45.3	11.3	7.66	13.3	434.0	242.0	103.0	57.3	5.058824	Fair biological quality	Fair
Mar_3_18	11.0	4.0	6.95	14.2	427.0	258.0	91.4	20.0	5	Poor biological quality	Fair
Mar_4_18	7.3	3.7	6.6	14.4	438.0	389.0	92.2	9.7	2.636364	Very poor biological quality	Very poor
Apr_1_18	78.7	10.3	7.4	16.0	422.0	193.0	93.0	49.3	4.774194	Poor biological quality	Poor
Apr_2_18	183.3	16.7	16.7	15.4	406.0	114.0	102.0	100.7	6.04	Good biological quality	Good
Apr_3_18	45.7	5.3	7.5	17.9	518.0	237.0	89.8	25.0	4.68	Poor biological quality	Poor
Apr_4_18	23.3	5.7	7.2	19.5	579.0	394.0	85.5	28.7	5.058824	Poor biological quality	Fair
May_1_18	102.3	12.0	7.6	19.0	520.0	234.0	98.7	52.3	4.361111	Fair biological quality	Poor
May_2_18	138.0	18.3	7.7	17.9	491.0	243.0	109.0	106.3	5.907407	Good biological quality	Good
May_3_18	11.0	6.3	7.2	18.9	612.0	259.0	94.6	32.7	5.157895	Poor biological quality	Fair
May_4_18	8.0	5.0	7.2	19.4	627.0	328.0	90.2	13.7	2.733333	Poor biological quality	Very poor
Jun_1_18	103.3	14.3	7.9	19.1	397.0	419.0	112.0	74.7	5.209302	Fair biological quality	Fair
Jun_2_18	67.7	18.3	7.9	18.3	374.0	402.0	114.0	90.7	5.037037	Good biological quality	Fair
Jun_3_18	17.0	7.7	7.6	20.4	523.0	465.0	98.0	33.0	4.304348	Poor biological quality	Poor
Jun_4_18	8.0	4.3	7.4	21.1	511.0	464.0	93.0	7.0	1.615385	Very poor biological quality	Very poor
Jul_1_18	57.3	13.3	7.2	20.4	522.0	292.0	90.4	58.7	4.4	Fair biological quality	Poor
Jul_2_18	27.3	14.0	7.45	19.2	428.0	243.0	98.9	74.0	5.285714	Fair biological quality	Fair
Jul_3_18	15.0	5.7	7.1	19.8	574.0	257.0	80.4	21.3	3.764706	Poor biological quality	Very poor
Jul_4_18	9.0	4.3	6.8	20.1	634.0	255.0	78.2	9.0	2.076923	Very poor biological quality	Very poor
Aug_1_18	41.0	10.3	7.9	19.3	465.0	383.0	63.3	46.7	4.516129	Poor biological quality	Poor
Aug_2_18	31.3	12.7	7.7	18.2	432.0	317.0	89.4	64.7	5.105263	Fair biological quality	Fair
Aug_3_18	18.0	6.0	7.1	18.9	538.0	402.0	71.2	20.3	3.388889	Poor biological quality	Very poor
Aug_4_18	5.7	3.7	6.5	19.2	592.0	418.0	56.9	8.0	2.181818	Very poor biological quality	Very poor
Sep_1_18	60.0	13.0	7.4	22.8	562.0	200.0	78.7	48.0	3.692308	Poor biological quality	Very poor
Sep_2_18	79.0	14.0	7.2	19.1	328.0	224.0	92.1	60.3	4.309524	Fair biological quality	Poor
Sep_3_18	27.3	6.7	6.8	22.9	444.0	233.0	88.8	15.0	2.25	Poor biological quality	Very poor
Sep_4_18	7.3	4.0	5.9	24.3	591.0	271.0	60.2	7.0	1.75	Very poor biological quality	Very poor

Biological and Water quality results - Nabão





CCA Families and environmental variables



River Habitat Survey - Introdução

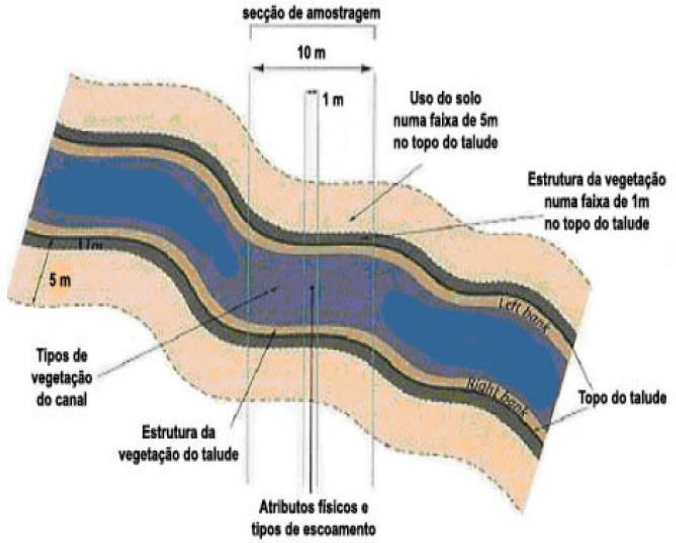
- Com o objetivo de complementar as avaliações da qualidade da água a partir de índices físico-químicos e biológicos recorreu-se ao método River Habitat Survey (RHS), que considera as características importantes para os organismos e a quantificação das alterações que ocorrem nos rios (Hughes et al, 2008).

- O River Habitat Survey (RHS) foi desenvolvido pela *Environment Agency* (Reino Unido) como metodologia de avaliação morfológica dos rios (Raven et al., 1998), e tem em vista a obtenção de informação indispensável à adequada gestão dos recursos hídricos no âmbito da aplicação da Diretiva-Quadro da Água (Diretiva 60/2000/CE, do Parlamento Europeu e do Conselho, de 23 de Outubro de 2000).

River Habitat Survey - Metodologia

- O método RHS consiste no levantamento de troços de 500 m de cursos de água, preenchendo um formulário específico que contempla uma caracterização geral com base na observação da totalidade daquela extensão, e ainda de uma forma mais particular em 10 pontos equidistantes. Nestes últimos, são observadas as características e as modificações do canal (Environment Agency, 2003).

- A recolha de dados incide sobre o tipo e estrutura da vegetação, atributos geomorfológicos e tipo de escoamento, repartidos pelo canal, taludes e topo dos taludes.



River Habitat Survey - Metodologia

- O RHS permite determinar várias métricas (variáveis explicativas) como o índice *Habitat Quality Assessment* (HQA) e o índice *Habitat Modification Score* (HMS).
- Índice *Habitat Quality Assessment* (HQA): é determinado pela presença e extensão das características do habitat das espécies autóctones de reconhecido interesse.
- Índice *Habitat Modification Score* (HMS): permite medir a extensão com que as características naturais da secção de amostragem se encontram antropicamente modificadas.

River Habitat Survey - Resultados

Habitat Quality Assessment (HQA)

Sample No	FLOW	CHANNEL SUBSTR.	CHANNEL FEATURES	BANK FEATURES	BANK VEG. STRUCTURE	IN-STREAM CHANNEL VEG.	LAND-USE	TREES ASSOC. FEATURES	SPECIAL FEATURES	HQA SCORE	No. Not Visible records	No. Missing values
LIS **01**	6	6	5	0	9	12	2	4	1	**45**	0	0
LIS **02**	8	5	5	2	12	4	0	10	2	**48**	9	0
LIS **03**	6	4	0	1	6	5	0	6	0	**28**	6	0
NABÃO **1**	6	5	2	10	11	7	0	8	0	**49**	11	0
NABÃO **2**	8	4	1	2	12	11	2	13	2	**55**	5	0
NABÃO **3**	5	3	3	2	12	3	2	9	3	**42**	18	0
NABÃO **4**	9	4	2	3	12	6	1	10	2	**49**	5	0

River Habitat Survey - Resultados

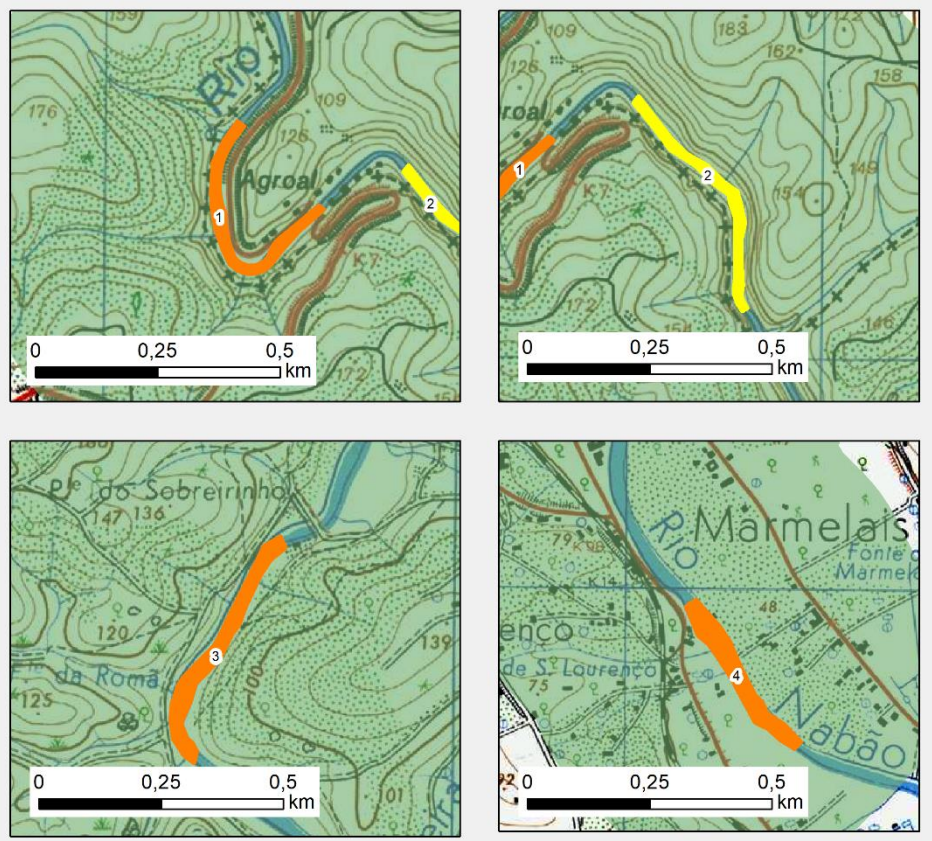
Habitat Modification Score (HMS)

Survey No.	CULVERTS	BANK AND BED RE-INFORCE-MENT	BANK AND BED RE-SECTIONING	BERMS AND EMBANK-MENTS	WEIRS DAMS AND SLUICES	BRIDGES	POACHING	FORDS	OUTFALLS AND DEFLECTORS	HMS_Score	HMC
LIS 01	0	950	760	0	75	400	0	0	100	2285	5
LIS 02	400	80	760	0	0	250	0	0	75	1565	5
LIS 03	0	440	960	0	300	650	0	0	750	3100	5
NABÃO 1	0	130	320	0	0	250	0	0	0	700	4
NABÃO 2	0	70	80	0	50	0	0	0	0	200	3
NABÃO 3	0	310	240	0	255	250	0	0	125	1180	4
NABÃO 4	0	230	560	0	180	0	0	0	100	1070	4

HMClassification Description
1 Pristine/Semi-natural
2 Predominantly unmodified
3 Obviously modified
4 Signficantly modified
5 Severely modified
0 Not classified

River Habitat Survey - Resultados

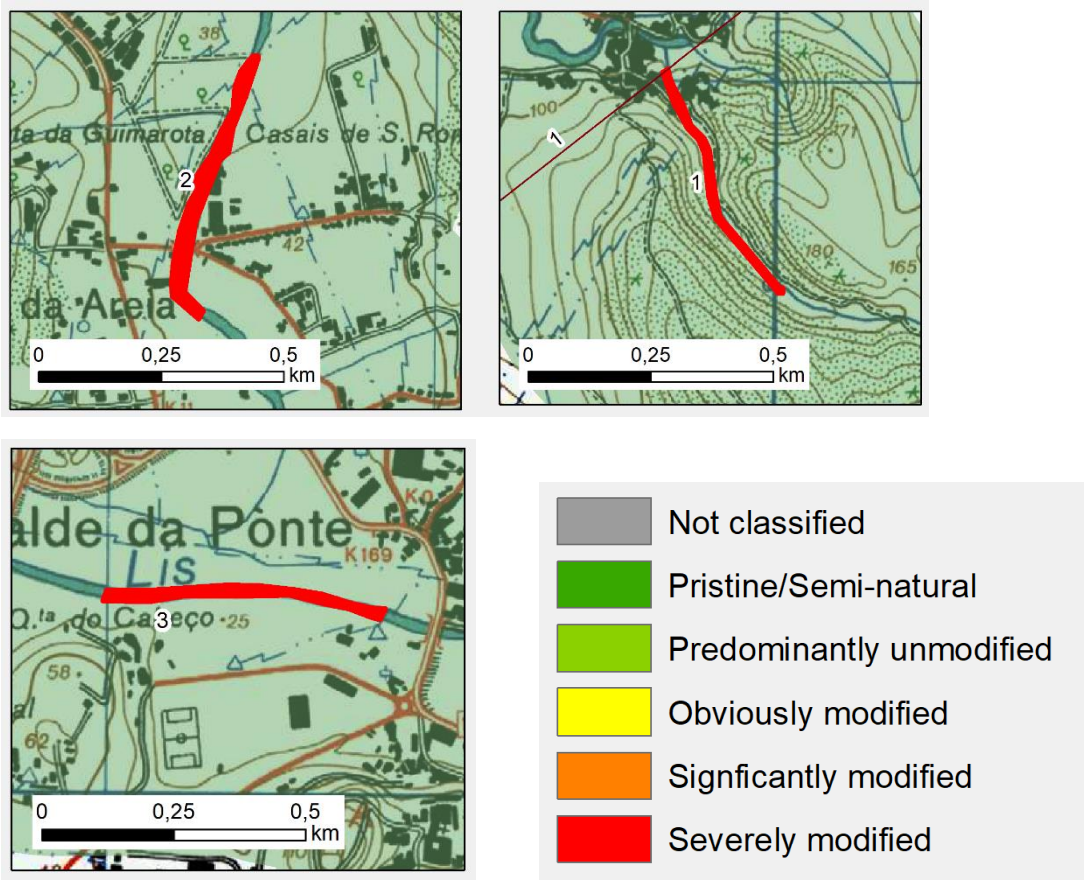
Habitat Modification Score - troços do rio Nabão:



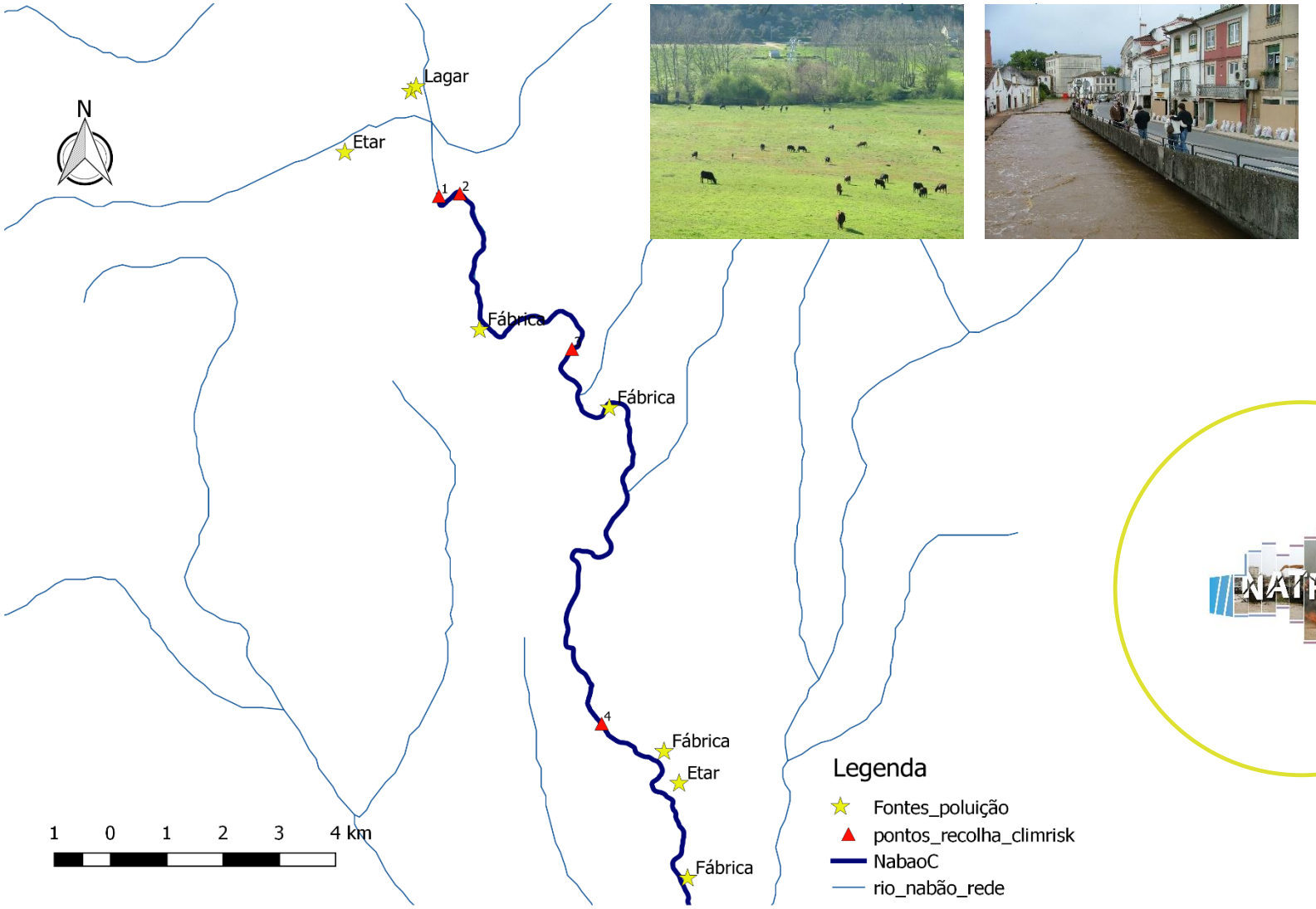
- Not classified
- Pristine/Semi-natural
- Predominantly unmodified
- Obviously modified
- Signficantly modified
- Severely modified

River Habitat Survey - Resultados

Habitat Modification Score obtido para os troços do rio Lis:



The Problems and the Risk



CLIM Risk

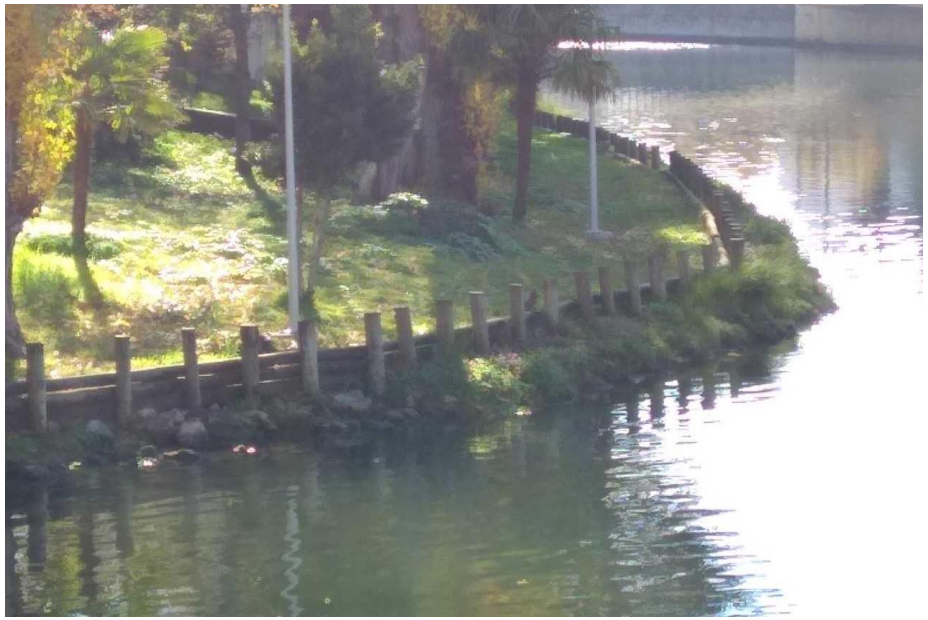
NATRISK

Mitigating the Risk

River margins

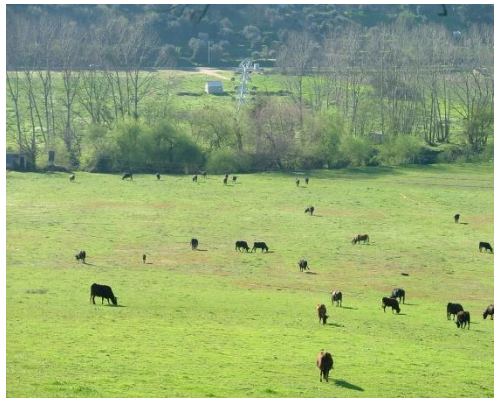
Before

After



Litter

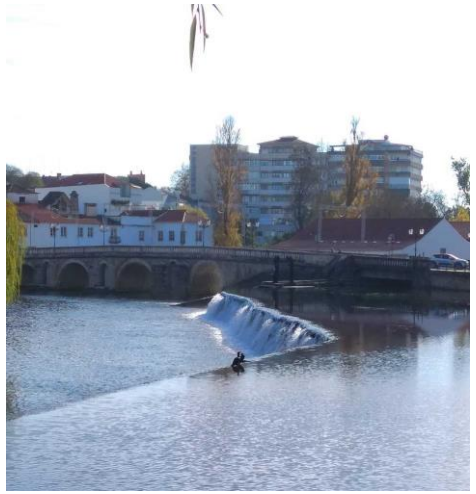
Agriculture

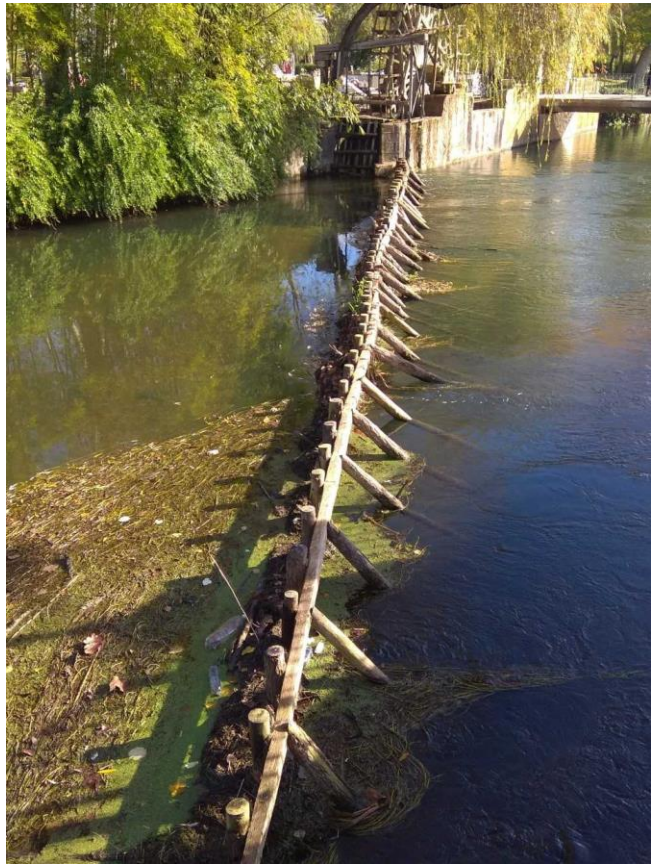


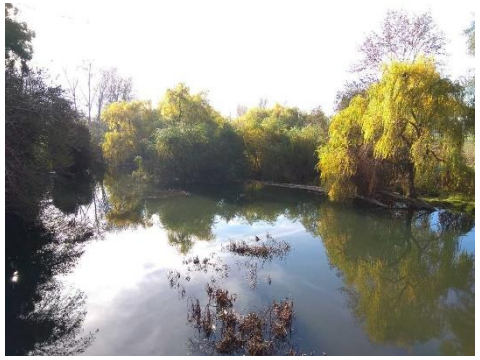
Erosion

Vegetation

In stream solutions





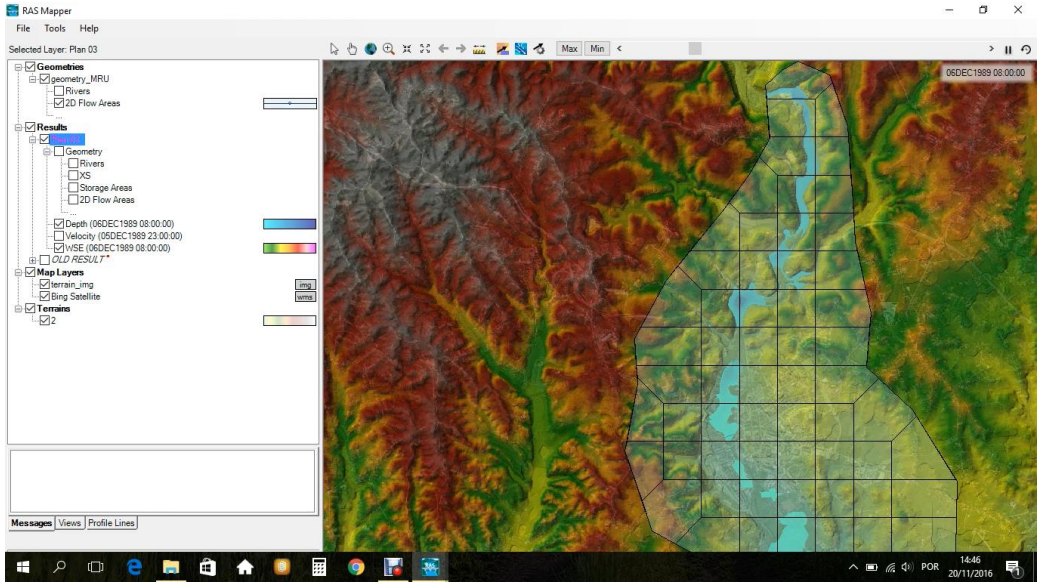


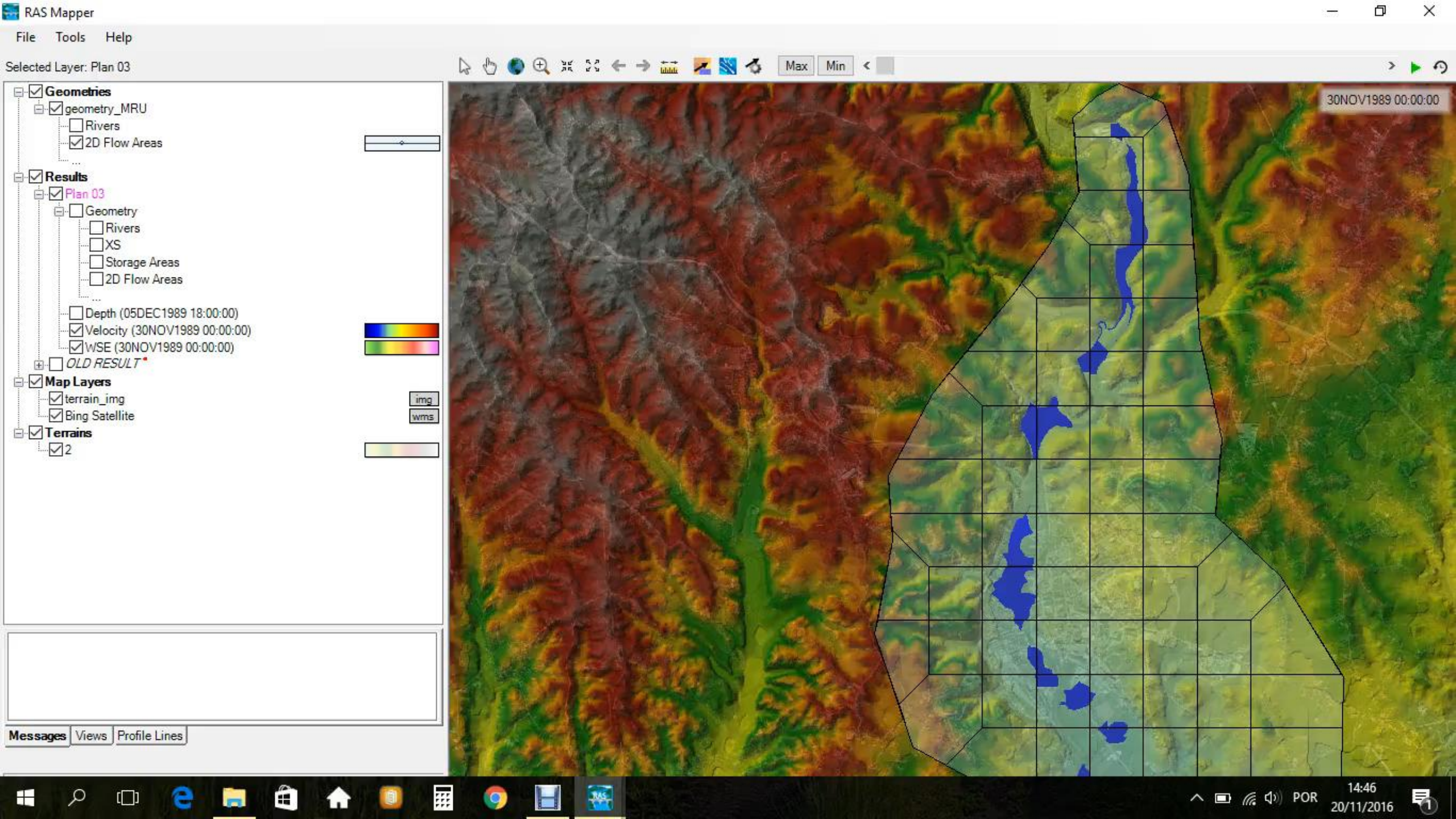
Environmental monitoring

Electrofishing

Biomonitoring

Flood monitoring

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Conclusions

- Intervene on the identified problems:
    - Riparian forest cleaning and restoration;
    - Maintenance and restoration of ditches and dams;
    - Litter maintenance from instream habitats;
    - Evaluate performance of sewage treatment stations.

- Developing an environmental and biological monitoring plan:
    - Pollution sources;
    - Water quality;
    - Bioindicators;

- Strategically build temporary ditches increasing oxygenation, reducing eutrophication and minimizing floods and guaranteeing Ecossistem Services.

Drinkable water is a current problem of the future implications,

Thank you.

Allow your children to have it!