Deltares

Enabling Delta Life

RB-Explorer

M7a –Water Quality and Ecology Workgroup

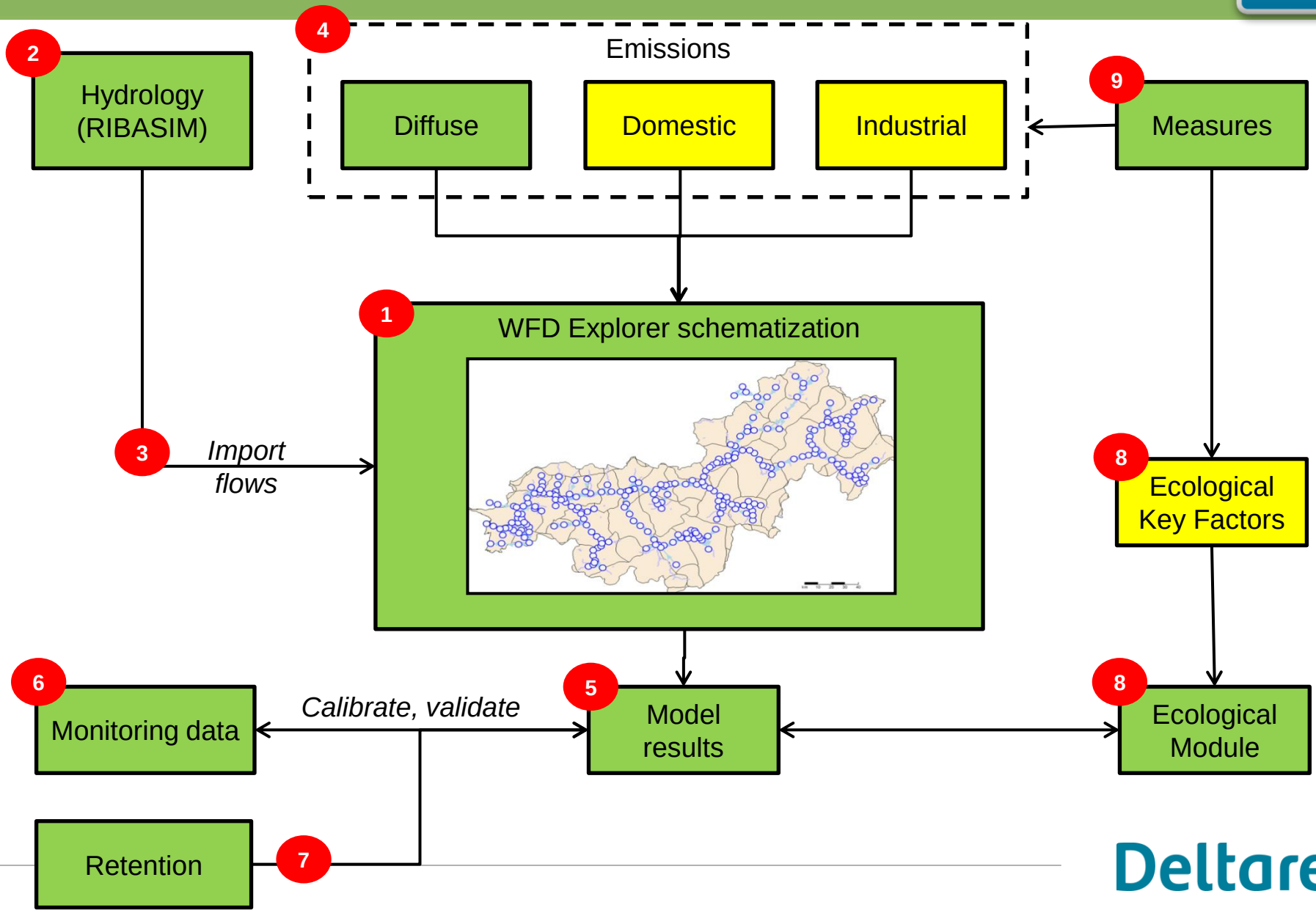
WFD-Explorer model wrap-up

7-8 September 2015, Ankara

Agenda

- Setup of the model
- Calibration
- Show results
- Implementation of the PUNN model in the WFD Explorer
- Extending the model (future improvements)
- Use of the model

Status: Today



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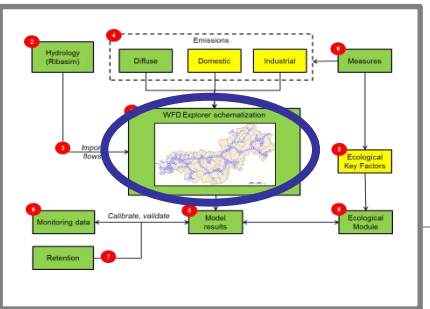
1. Schematization

Consists of:

- Water bodies (river and lakes/reservoirs) → Surface Water Units
- Districts → Basin Nodes

Based on:

- GIS maps
- Coupled to the RIBASIM schematisation



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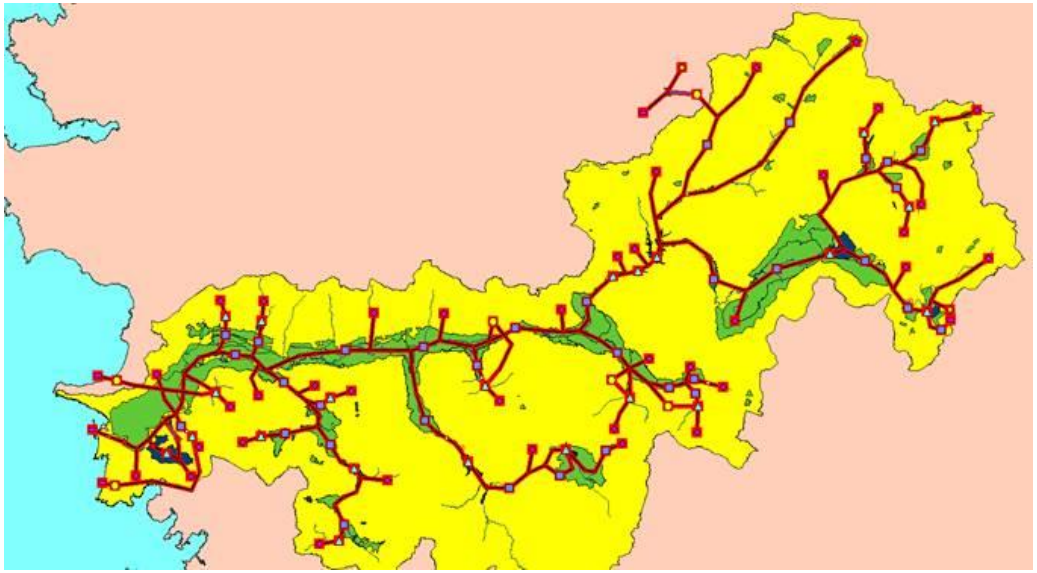
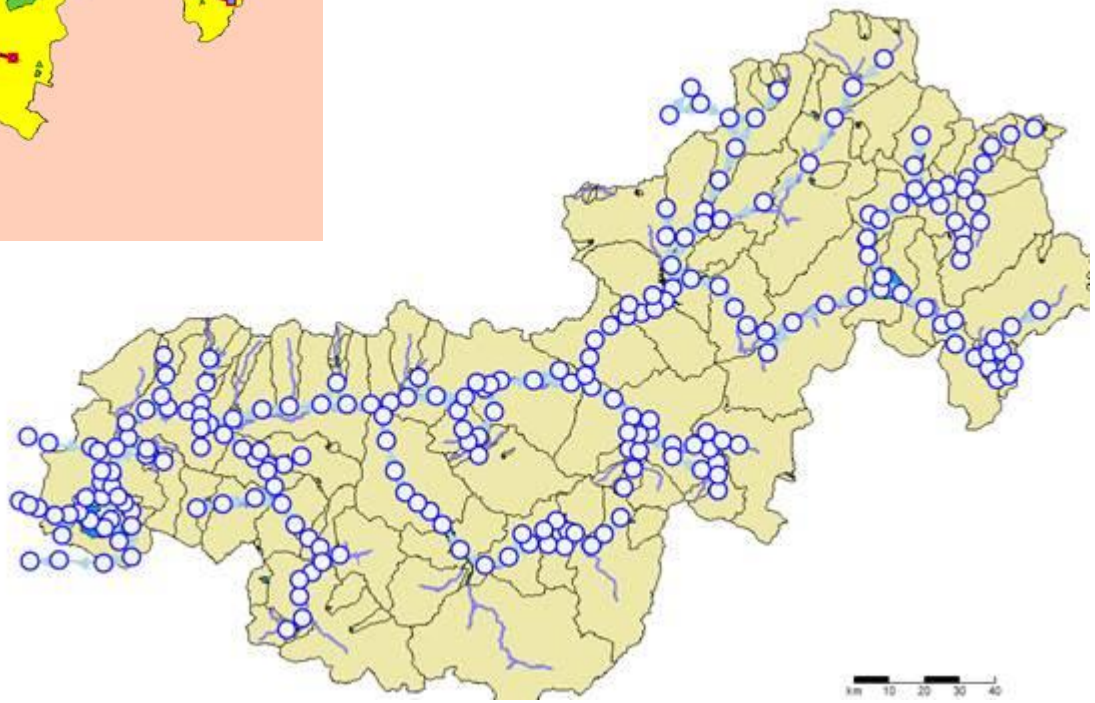
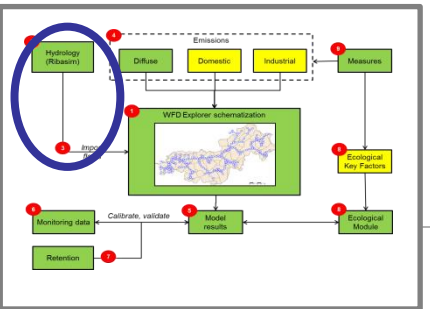
2 & 3. RIBASIM – WFD-Explorer coupling







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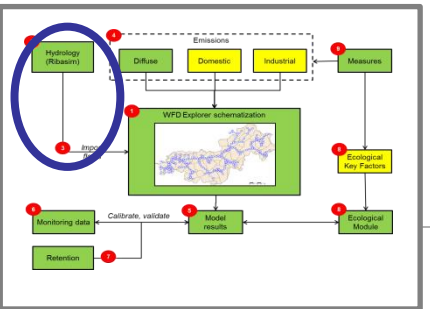
2 & 3. Final update of RIBASIM

Problem:

- Zero flows in some stretches when no runoff is available
- Domestic waste water flows were not included in the model

Added:

- Flow rate per capita
- Municipalities connected to RIBASIM infow nodes



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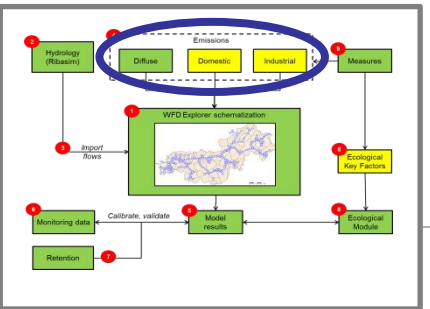
4. Emission Data

Source	*Type*	*Quality*	*Loads*
Diffuse	Diffuse, based on districts	Best available data	River basin protection action plan
Domestic	Point	Moderate, based on factors	Estimates based on factors and removal efficiency
Industrial	Point	Moderate, probably incomplete	Based on legislation



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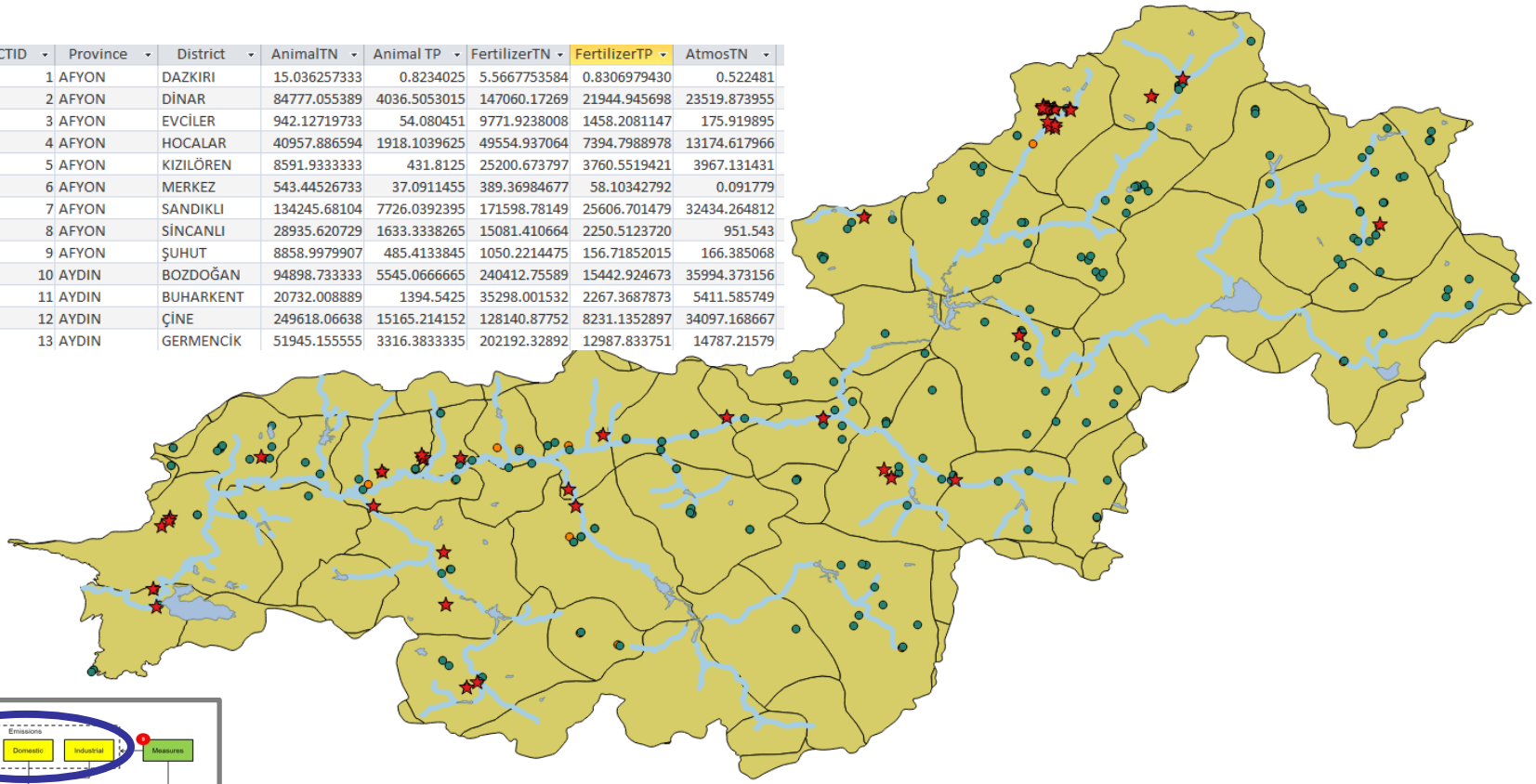
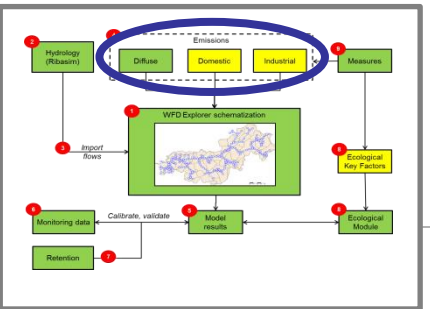
4. Diffuse Sources to Basins

Based on districts (67)

OBJECTID	Province	District	AnimalTN	Animal TP	FertilizerTN	FertilizerTP	AtmosTN
1	AFYON	DAZKIRI	15.036257333	0.8234025	5.5667753584	0.8306979430	0.522481
2	AFYON	DİNAR	84777.055389	4036.5053015	147060.17269	21944.945698	23519.873955
3	AFYON	EVCİLER	942.12719733	54.080451	9771.9238008	1458.2081147	175.919895
4	AFYON	HOCALAR	40957.886594	1918.1039625	49554.937064	7394.7988978	13174.617966
5	AFYON	KIZILÖREN	8591.9333333	431.8125	25200.673797	3760.5519421	3967.131431
6	AFYON	MERKEZ	543.44526733	37.0911455	389.36984677	58.10342792	0.091779
7	AFYON	SANDIKLI	134245.68104	7726.0392395	171598.78149	25606.701479	32434.264812
8	AFYON	SİNCANLI	28935.620729	1633.3338265	15081.410664	2250.5123720	951.543
9	AFYON	ŞUHUT	8858.9979907	485.4133845	1050.2214475	156.71852015	166.385068
10	AYDIN	BOZDOĞAN	94898.733333	5545.0666665	240412.75589	15442.924673	35994.373156
11	AYDIN	BUHARKENT	20732.008889	1394.5425	35298.001532	2267.3687873	5411.585749
12	AYDIN	ÇİNE	249618.06638	15165.214152	128140.87752	8231.1352897	34097.168667
13	AYDIN	GERMENCİK	51945.155555	3316.3833335	202192.32892	12987.833751	14787.21579





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4. Domestic Waste Water

Communities (185) → population

x

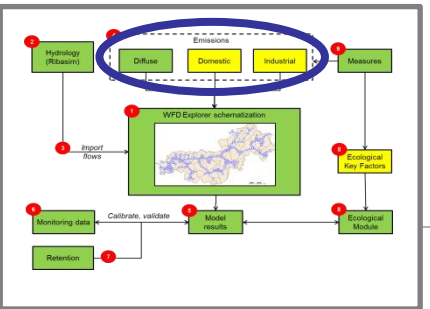
Emission factor (per inh.)

=

Load per community

Communities (185) → Sewer system → WWTP → Surface water

Communities (185) → Septic tank → Surface water



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4. Industrial loads

47 locations known

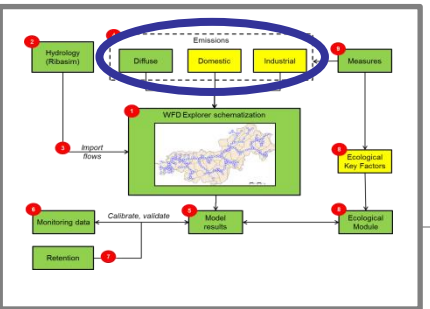
39 with discharge data

Loads computed based on tables:

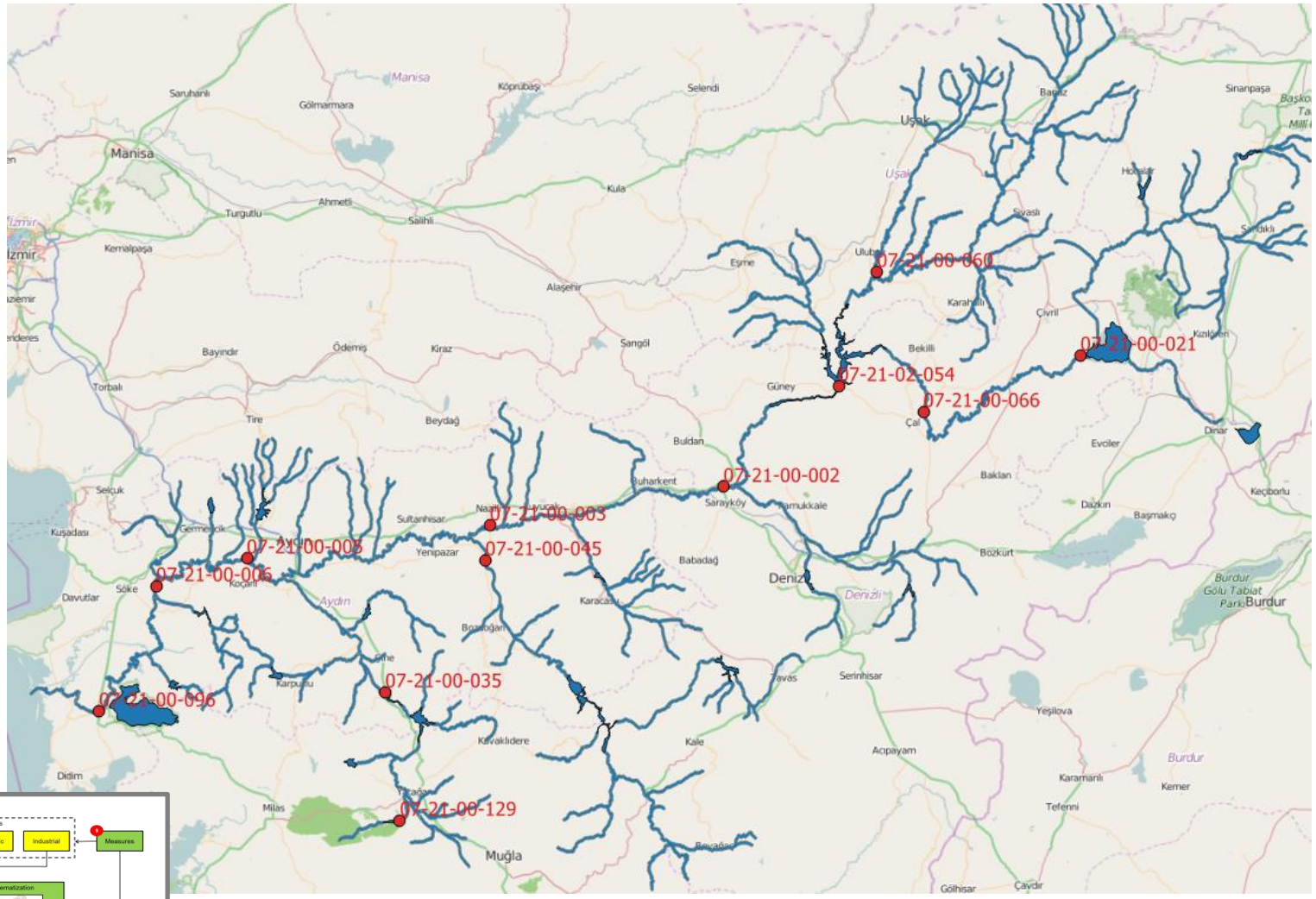
INDST_NO	INDST_NAME	longitude	latitude	RGLTN_NO	TRTMT_LEVE
1	Denizli Organize	29.23154	37.80375	19	SECONDARY
2	Gümüşsu Arıtma	29.07959	37.81036	10_3	SECONDARY
3	Ozanteks tekstil	29.06365	37.82858	10_3	SECONDARY
4	Akça Holding Me	28.92031	37.94992	10_3	SECONDARY
5	Konfurut Gıda Sa	29.38165	38.14389	5_9	SECONDARY
6	Aydın OSB	27.97893	37.85452	19	SECONDARY
7	Jantsa Jant Sana	27.98312	37.85541	15	SECONDARY

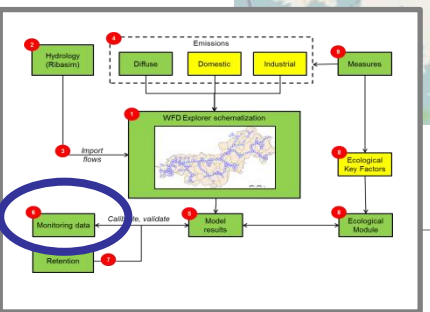
Tablo 10.3: Sektör: Tekstil Sanayii (Pamuklu Tekstil ve Benzerleri)

PARAMETRE	BİRİM	KOMPOZİT NUMUNE 2 SAATLİK	KOMPOZİT NUMUNE 24 SAATLİK
KİMYASAL OKSİJEN İHTİYACI (KOİ)	(mg/L)	250	200
ASKIDA KATI MADDE(AKM)	(mg/L)	160	120
AMONYUM AZOTU (NH_4-N)	(mg/L)	5	-
SERBEST KLOR	(mg/L)	0.3	-
TOPLAM KROM	(mg/L)	2	1
SÜLFÜR (S^{-2})	(mg/L)	0.1	-
SÜLFİT	(mg/L)	1	-
YAĞ VE GRES	(mg/L)	10	-
BALIK BİYODENEYİ (ZSF)	-	4	3
pH	-	6-9	6-9
(Ek satır:RG-24/4/2011-27914) Renk	(Pt-Co)	280	260



6. Monitoring locations for validation/calibration





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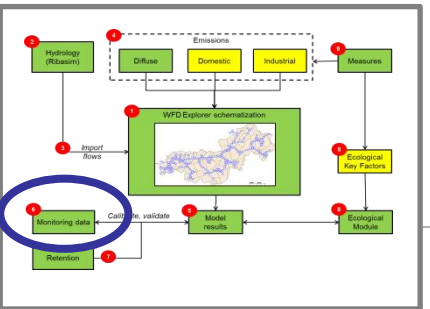
5 & 7. Data availability for modeled substances

Data type	Par.	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
monitoring	COD	54	54	56	49	73	25	54	54	58	47	68	36
	SS	58	58	56	55	82	60	55	48	59	58	68	46
	TN									33	58	47	46
	TP									53	58	55	46
RIBASIM	FLOWS		model	model	model	model	model	model	model				
Domestic loads	COD								Factors				
	SS								Factors				
	TN								Factors				
	TP								Factors				
Diffuse sources	TN							TUBITAK					
	TP							TUBITAK					
Industrial loads	COD									permits			
	SS									permits			
	TN									permits			
	TP									permits			



- Number of WQ samples of selected stations per year
- RIBASIM output for complete years
- Dom. loads based on population number and factors for 2010
- Diffuse sources based on TUBITAK data for 2009 → no SS source
- Industrial loads based on permits (2011)
- Emission data applied for all RIBASIM years

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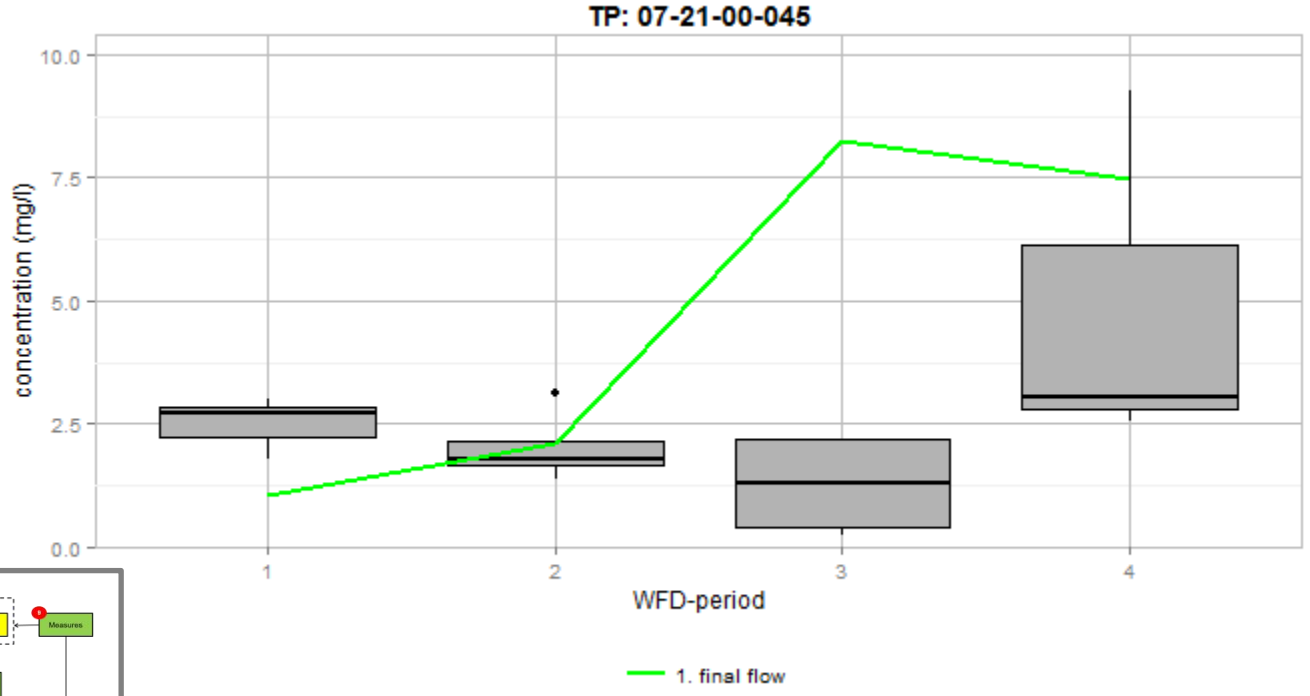
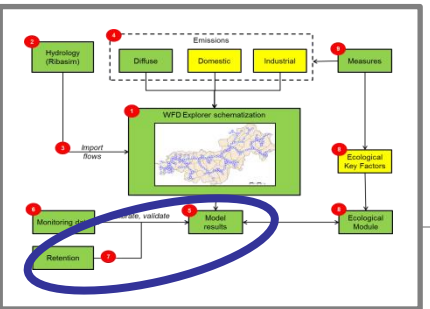
7. Calibration process (1):

1. Hydrological analysis:
   - Add flows per capita in RIBASIM
   - Minimal outflow of Cine reservoir





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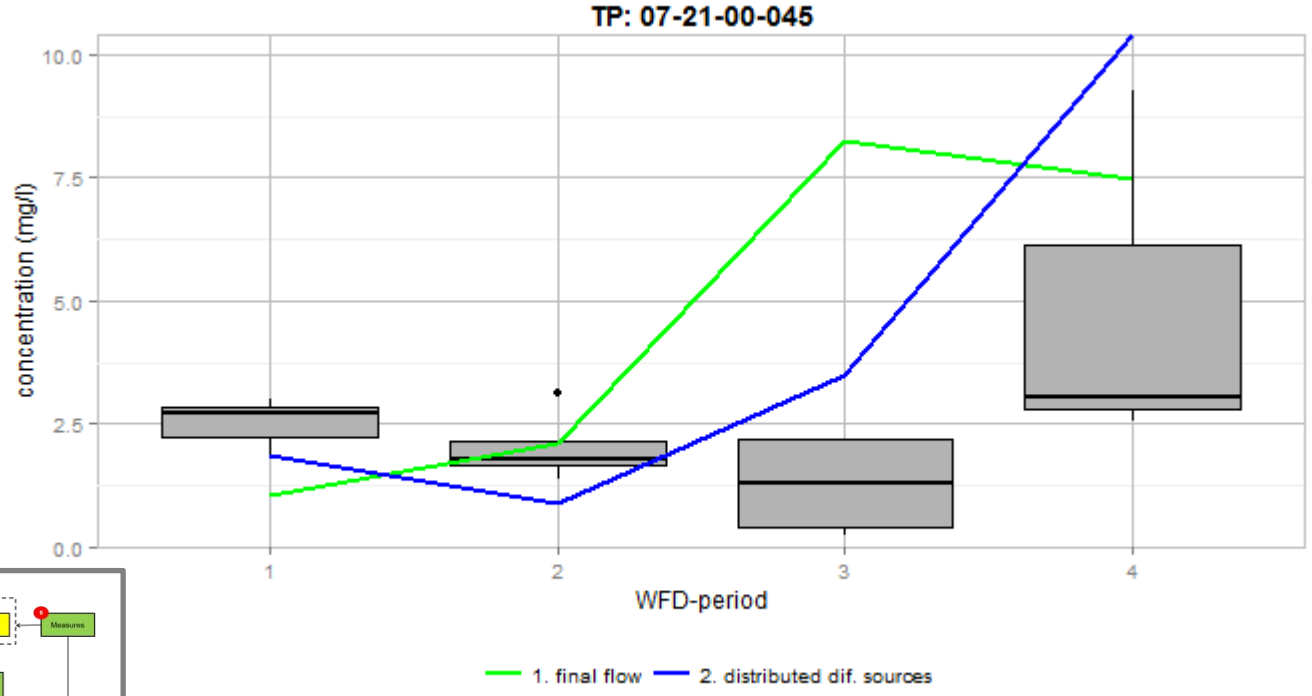
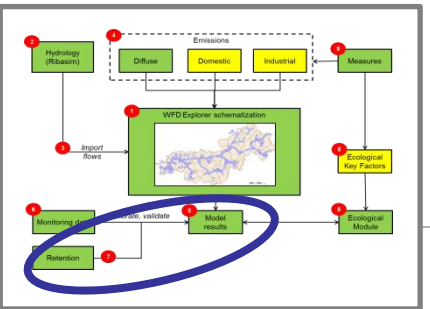
7. Calibration process (2):

2. Time dependent diffuse sources
   - They come with the runoff of the land
   - Peak in winter season





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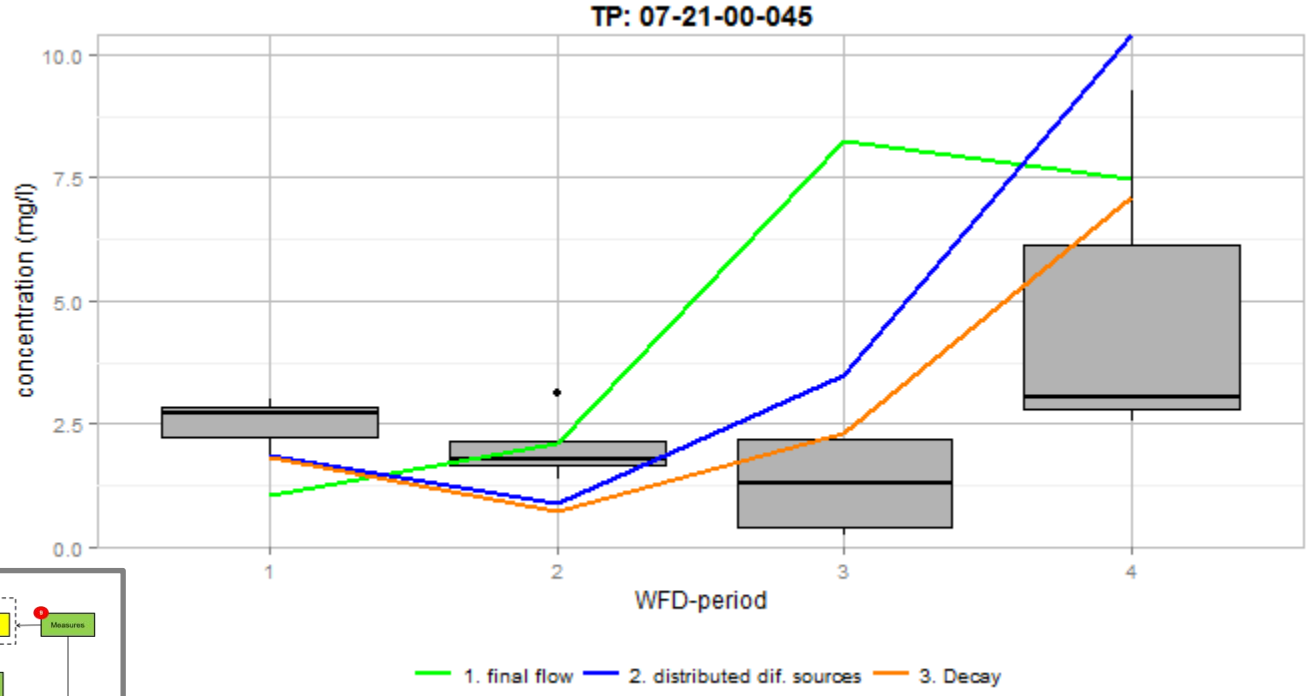
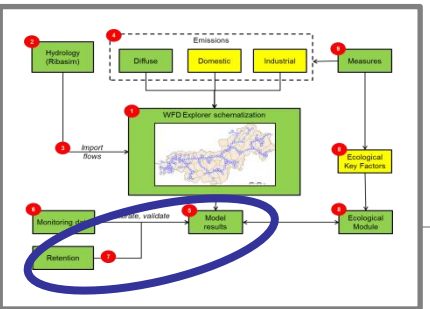
7. Calibration process (3):

3. Add decay:

- First order decay for TN, TP and COD (k =0.01 d^{-1})
- Related to residence time





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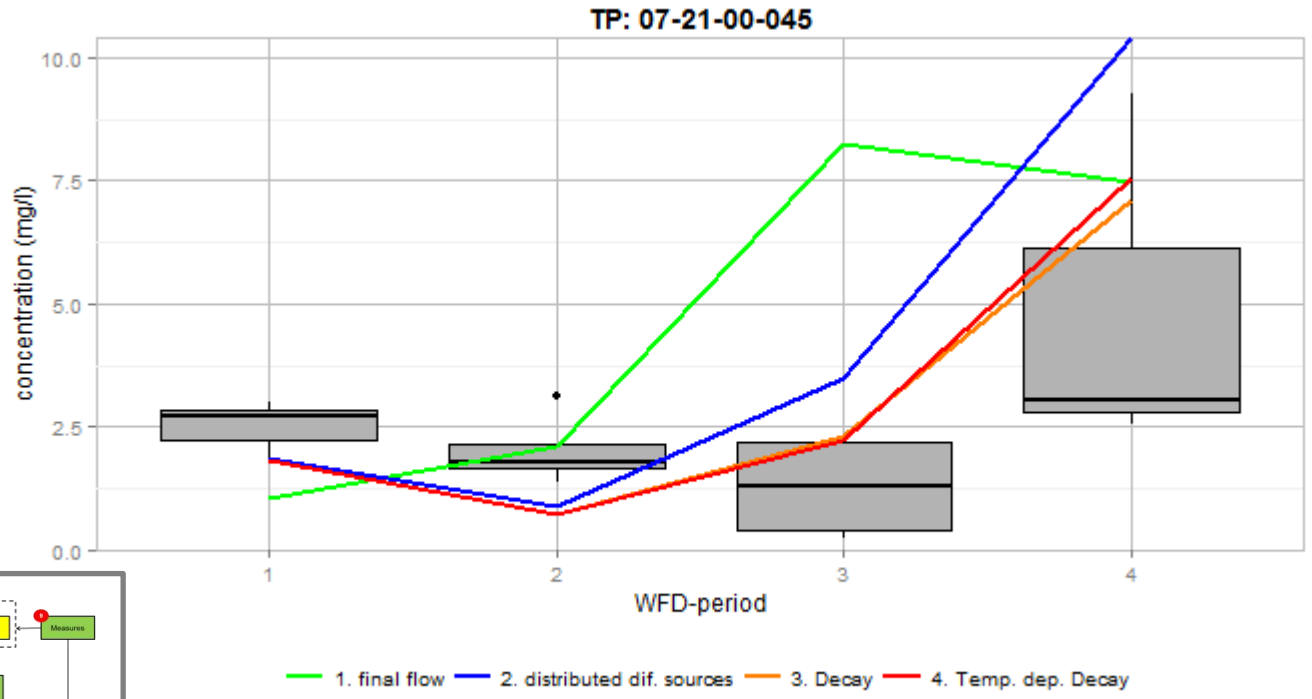
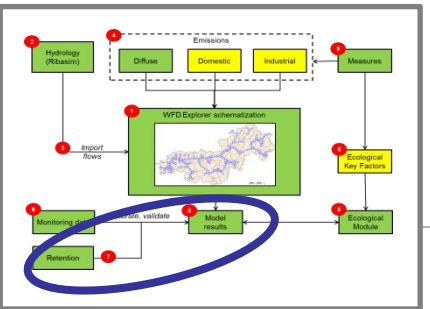
7. Calibration process (4):

4. Add temperature:

- Decay is dependent on water temperature:

  $k = k_{20} * theta^{(T-20)}$ with theta = 1.047





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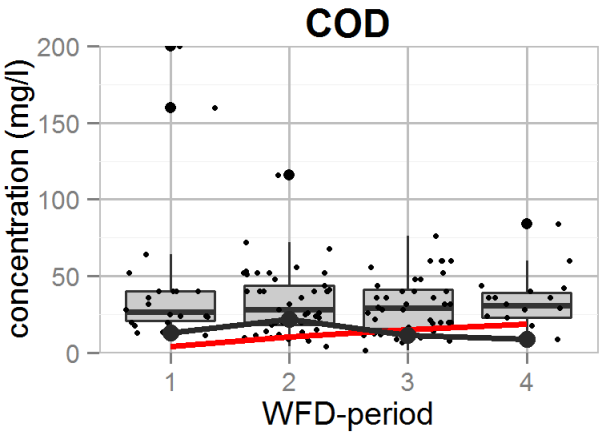
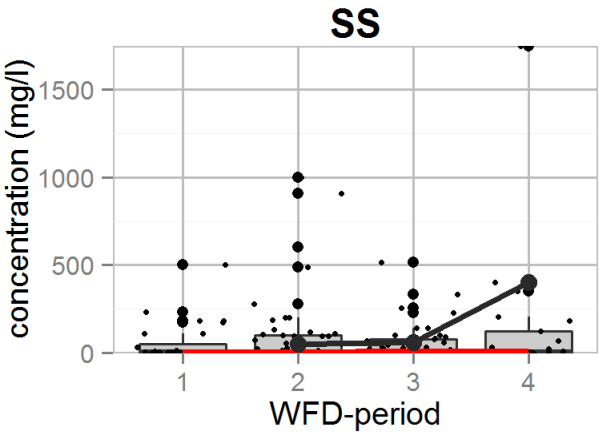
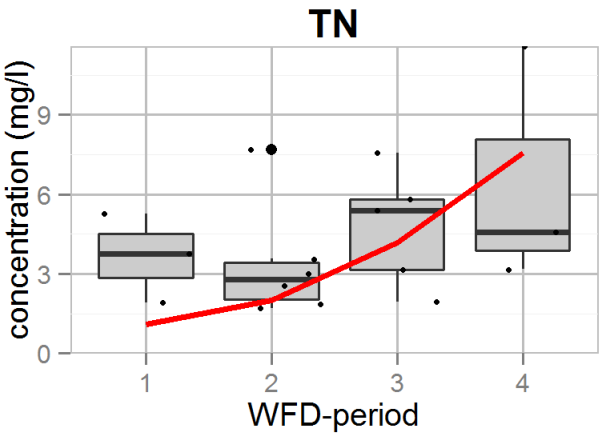
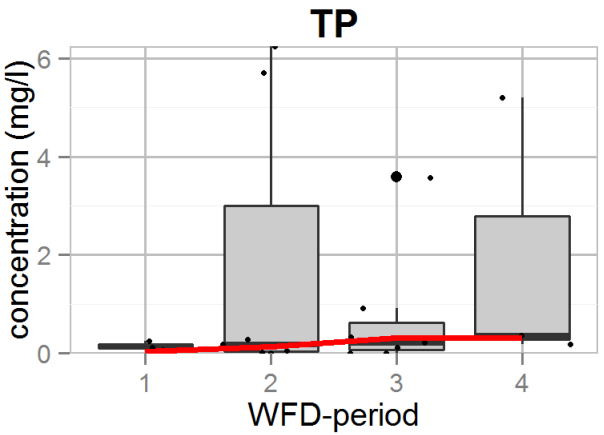
5. Downstream near Soke

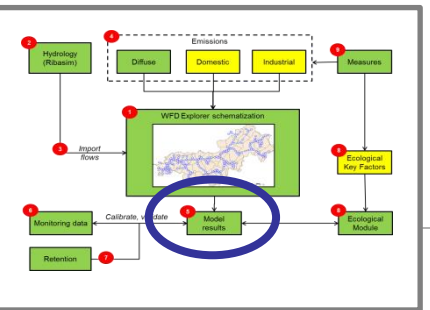
07-21-00-006











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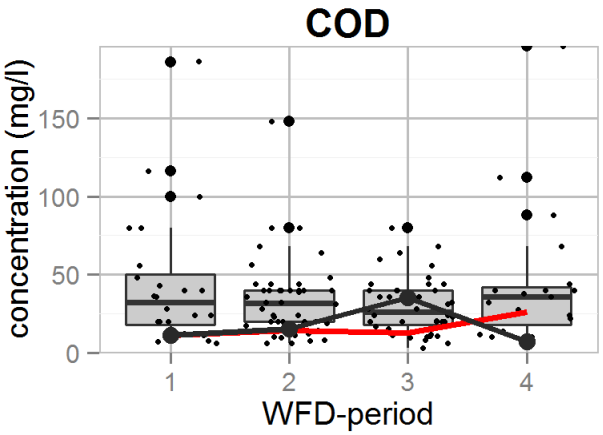
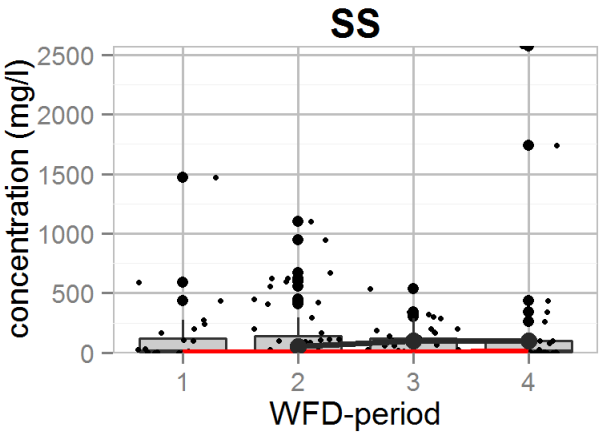
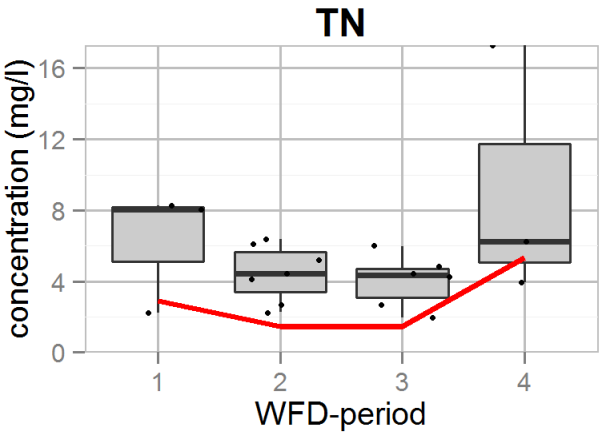
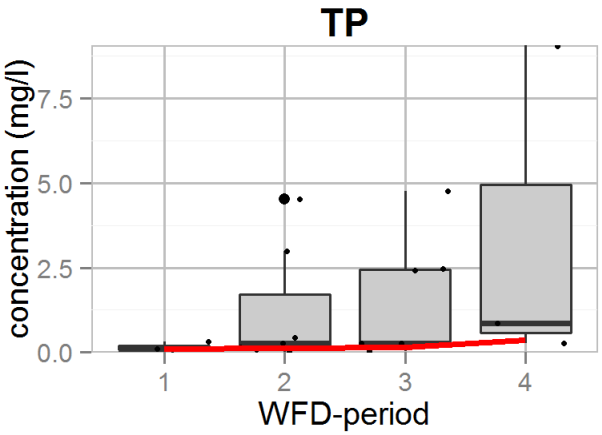
5. Downstream, near Nazilli

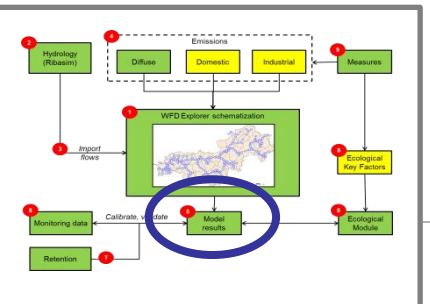
07-21-00-003











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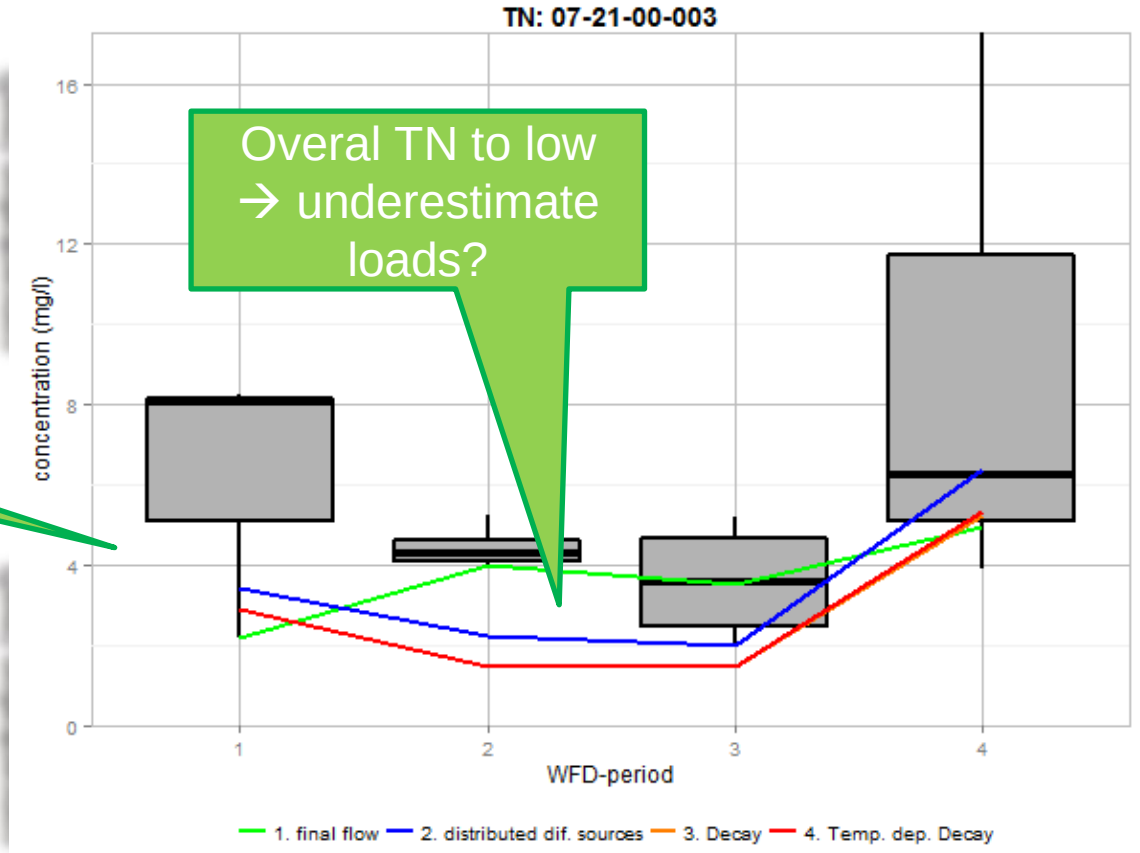
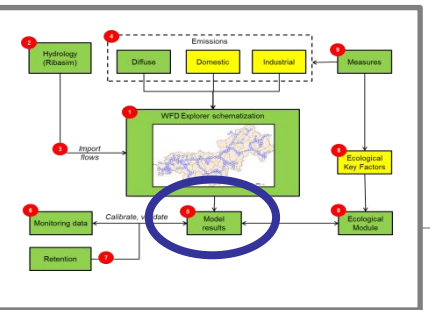
5. Downstream, near Nazilli (2)



Overal TN to low → underestimate loads?

Effect of decay is minimal



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5. Downstream of confluence Denizli trib.

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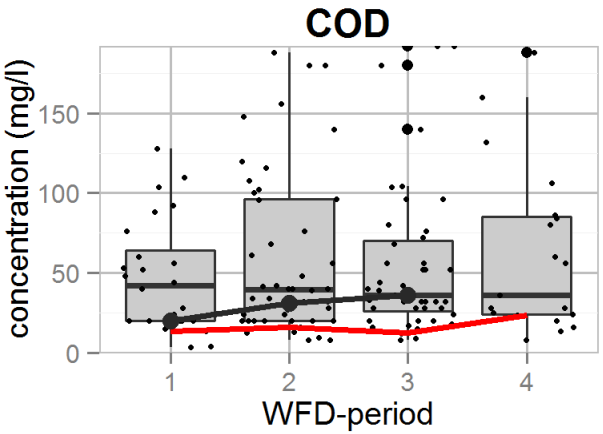

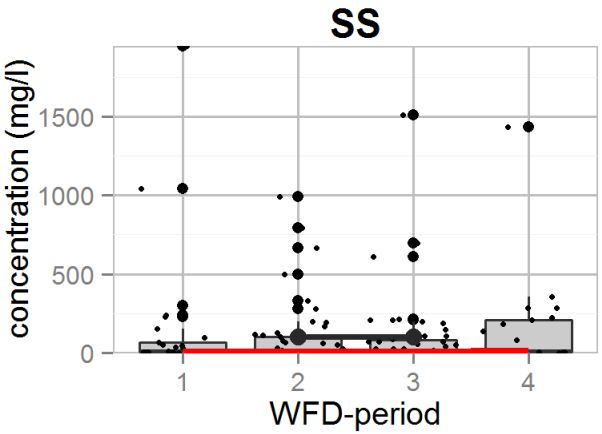

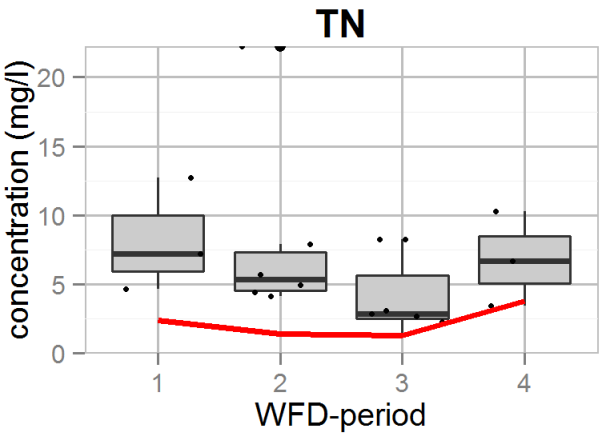

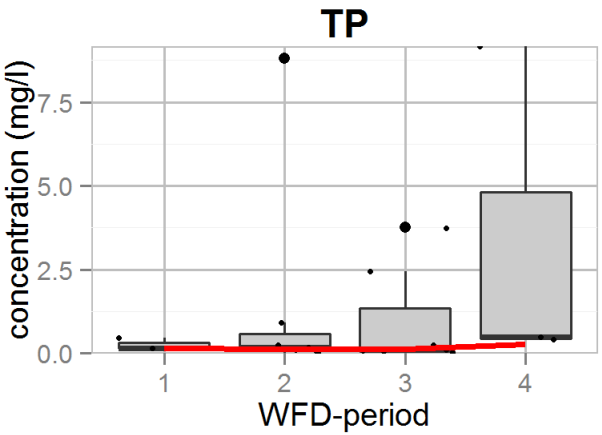

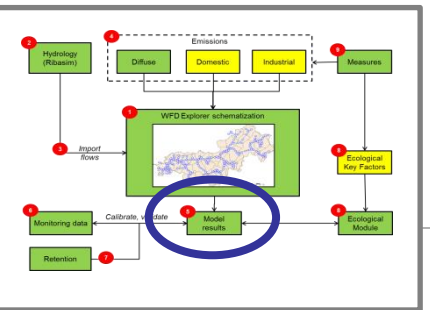

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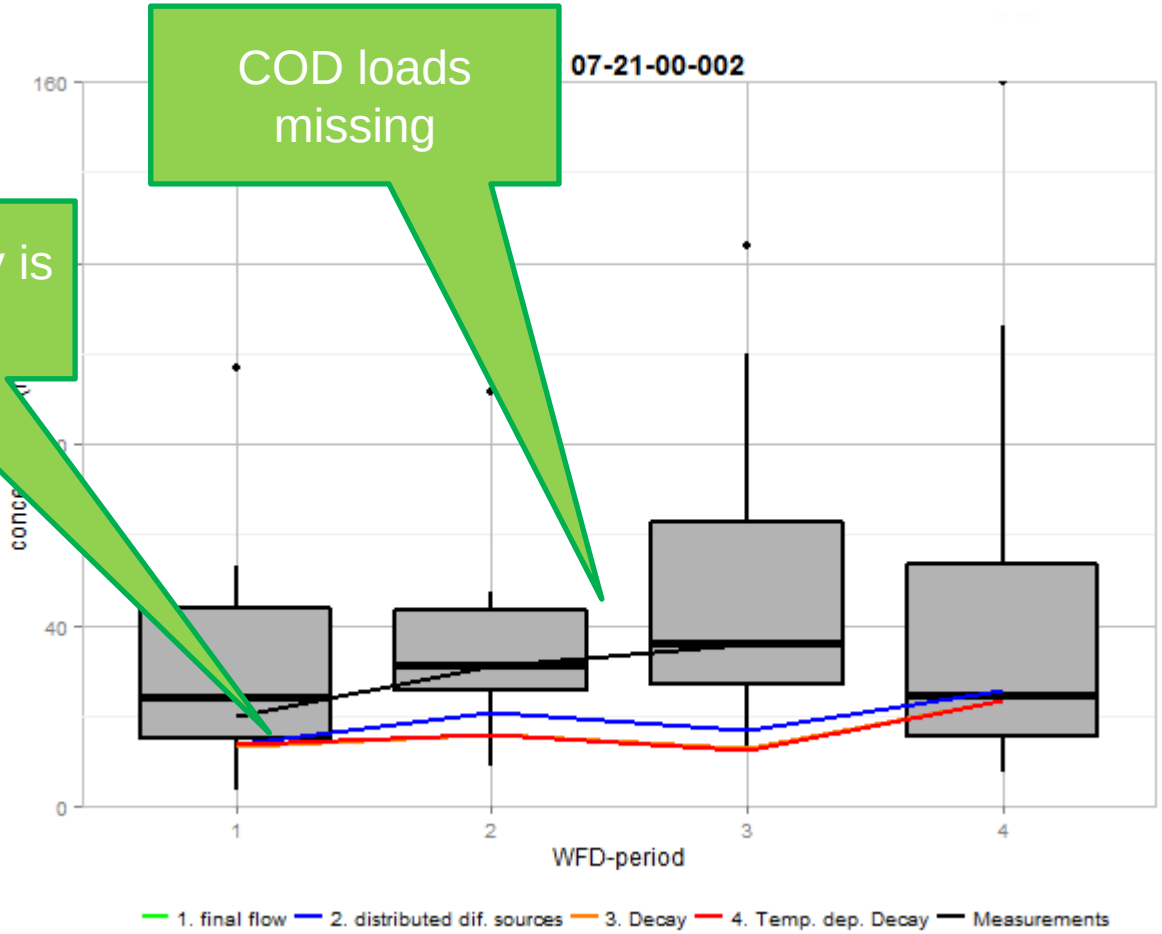
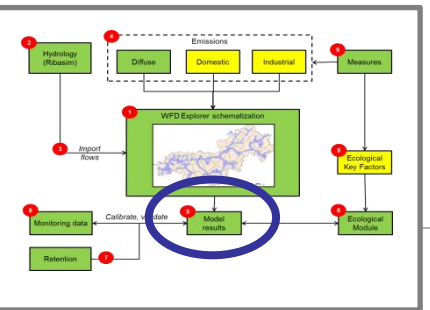
5. Downstream of confluence Denizli trib. (2)



COD loads missing

Effect of decay is minimal



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5. Cindere reservoir

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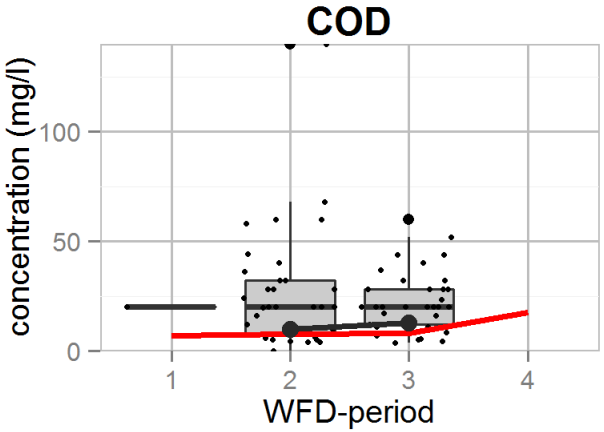
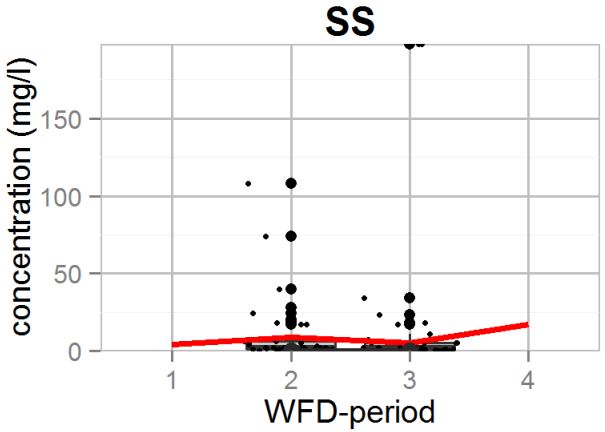
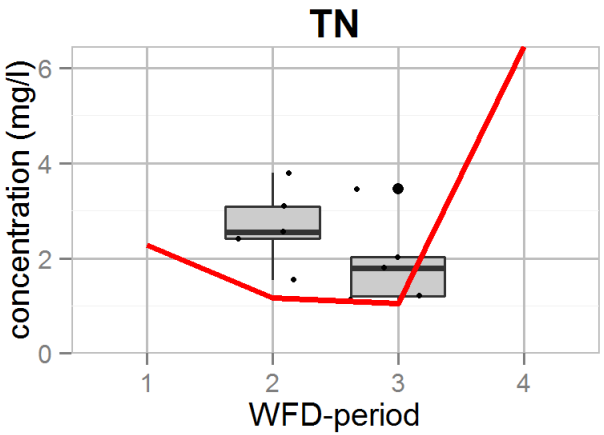
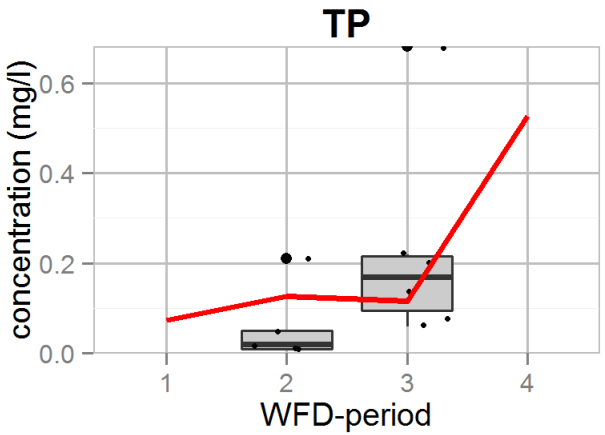
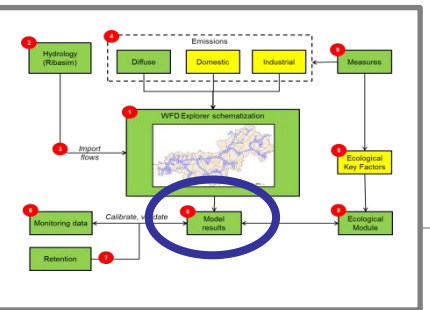






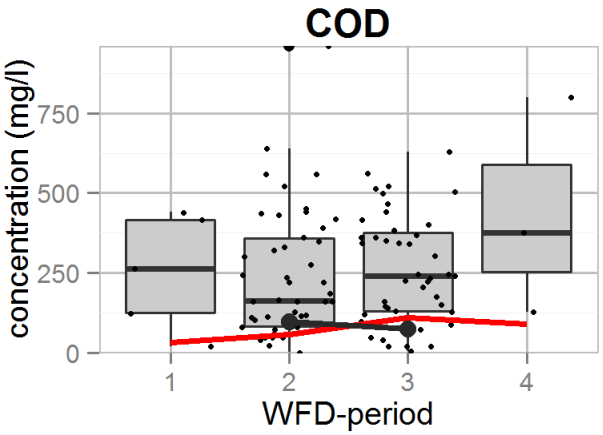


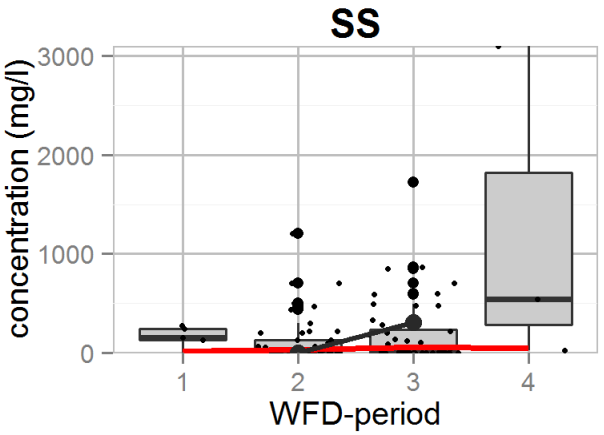


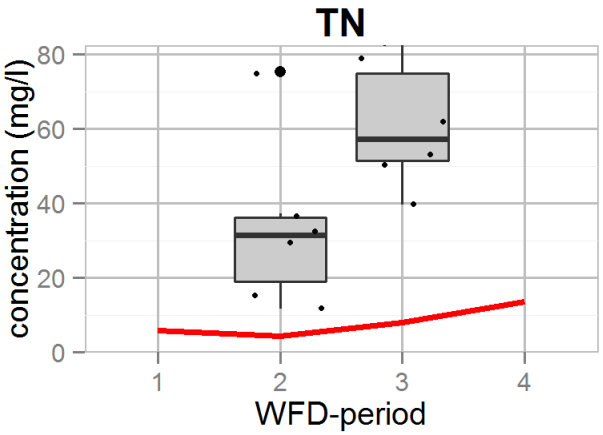
Deltares

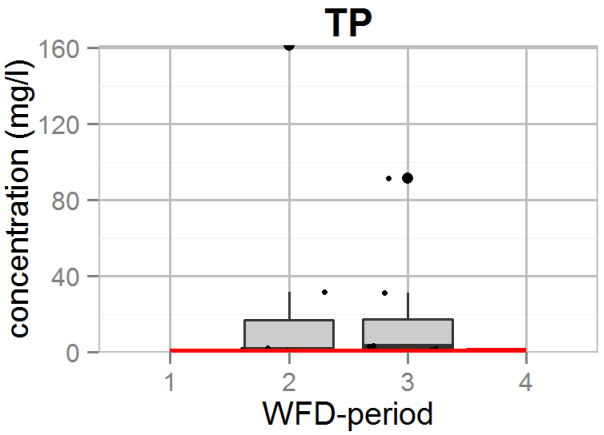
5. Banaz Creek

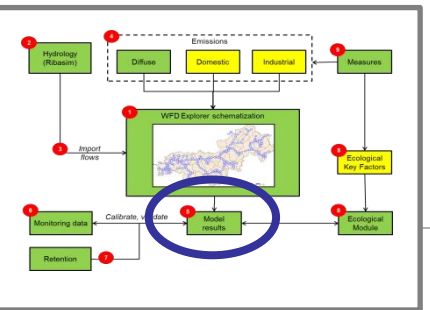
07-21-00-060





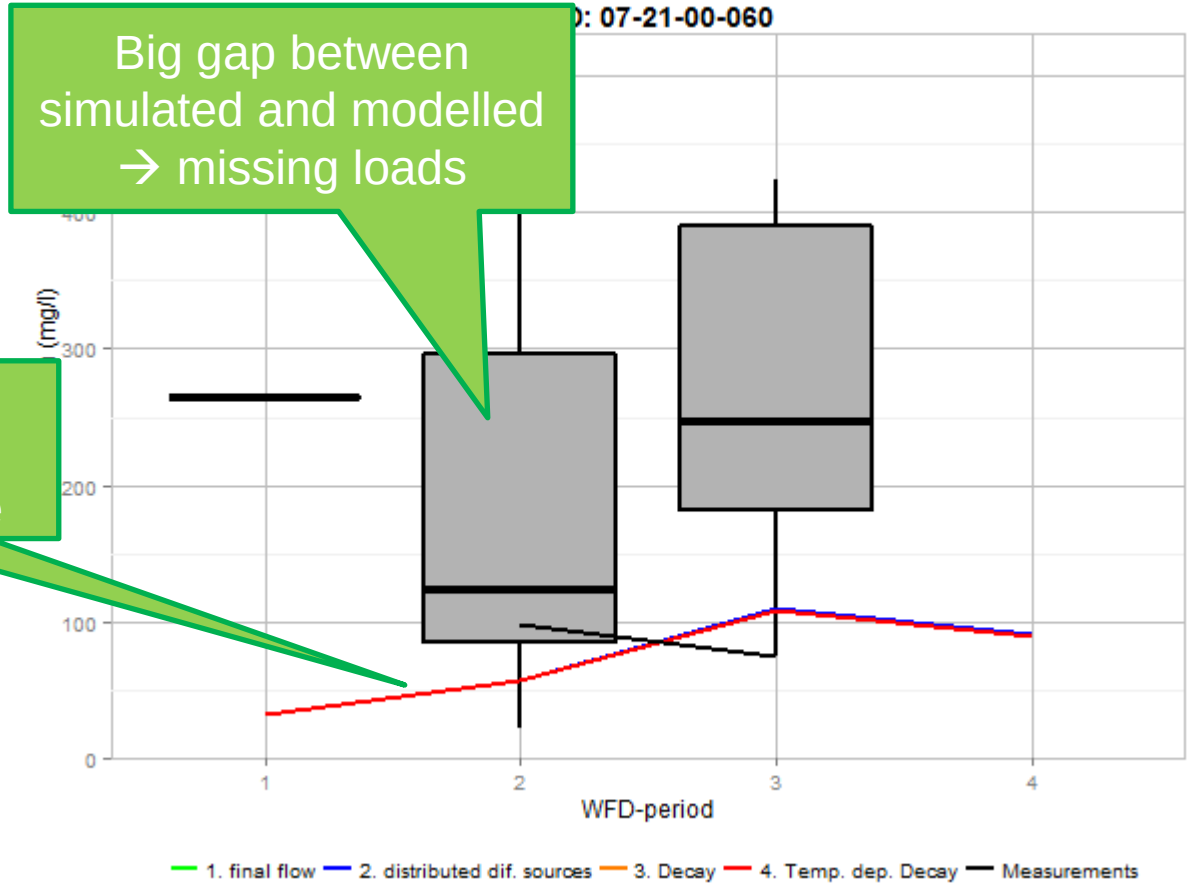


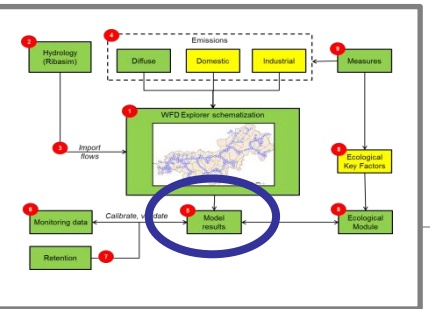




Deltares

5. Banaz Creek (2)

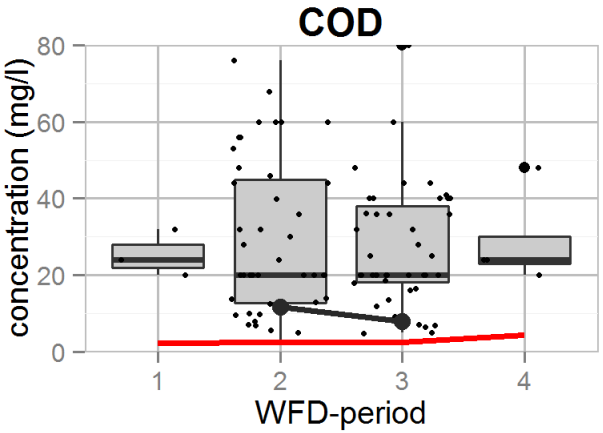


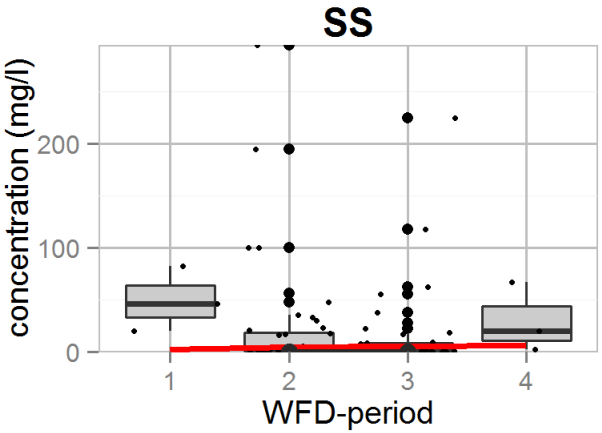


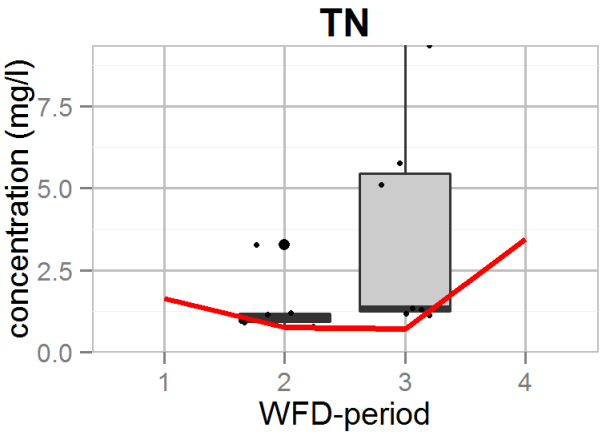
Deltares

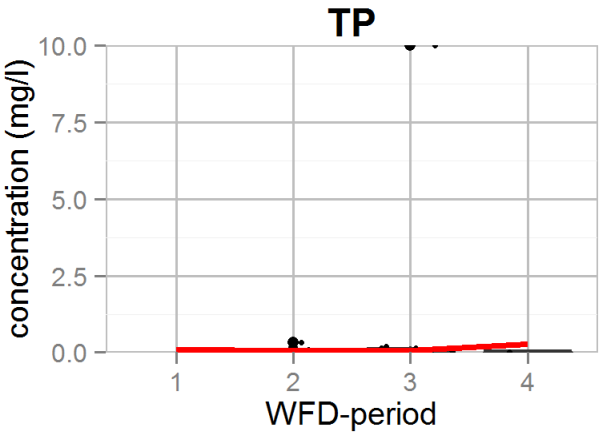
5. Downstream Isikli lake

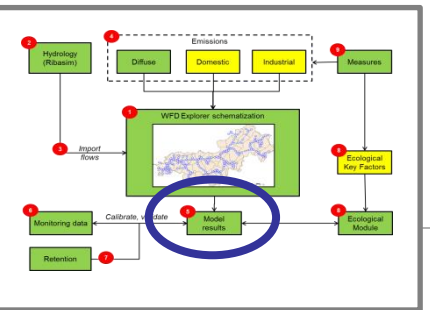
07-21-00-021





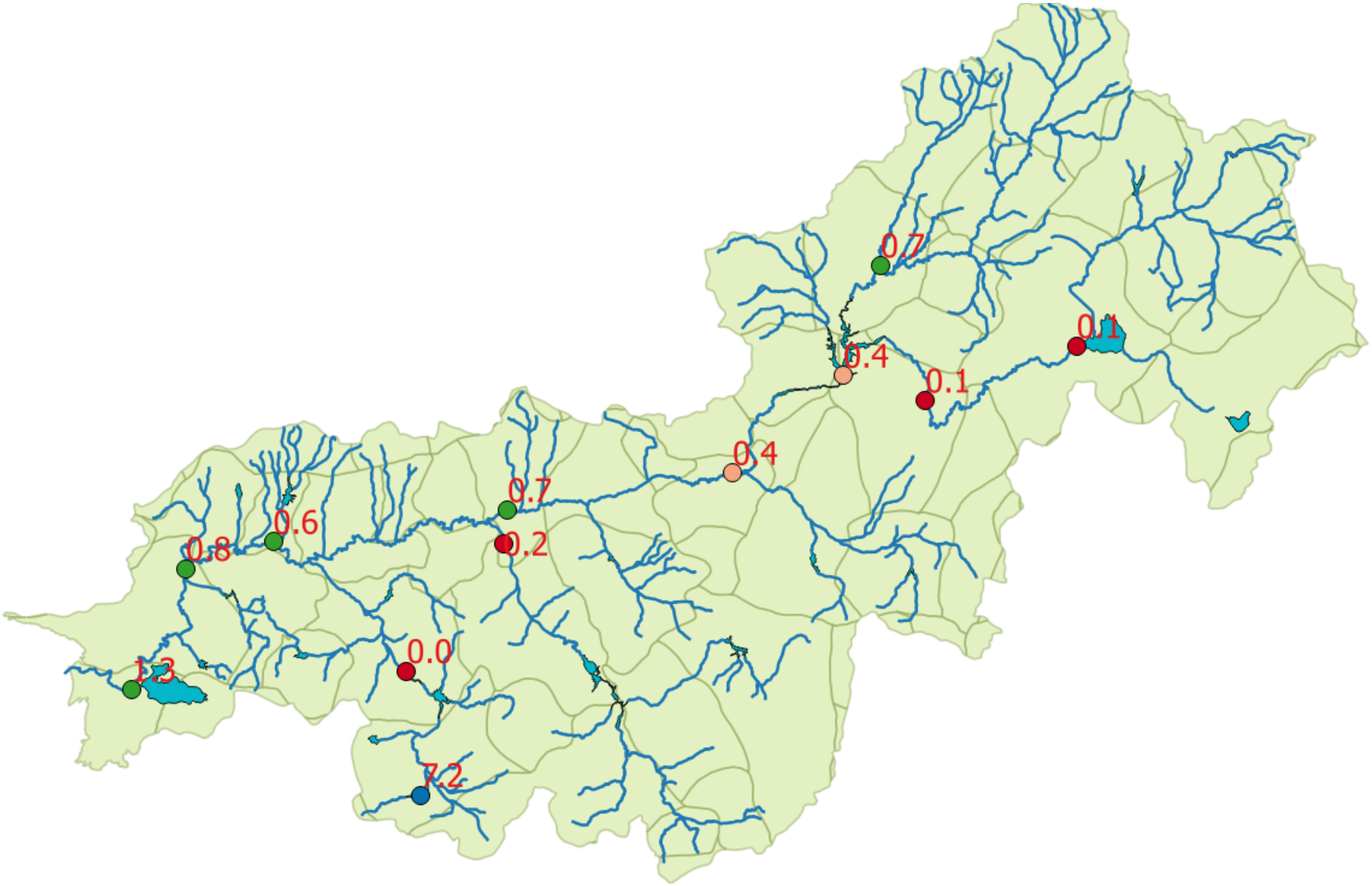






Deltares

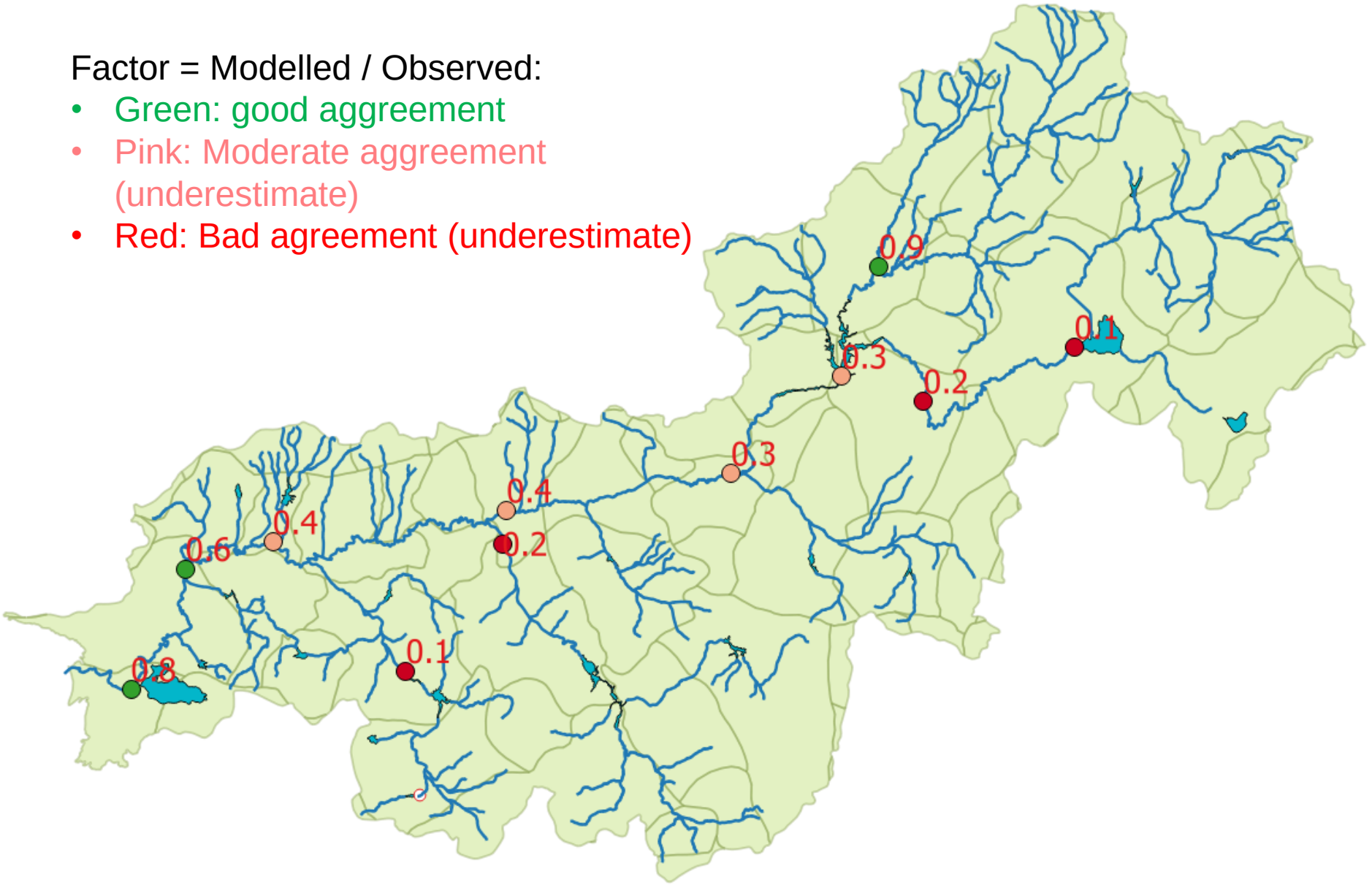
COD: Modeled (2010) vs. Observed (2011-2014)



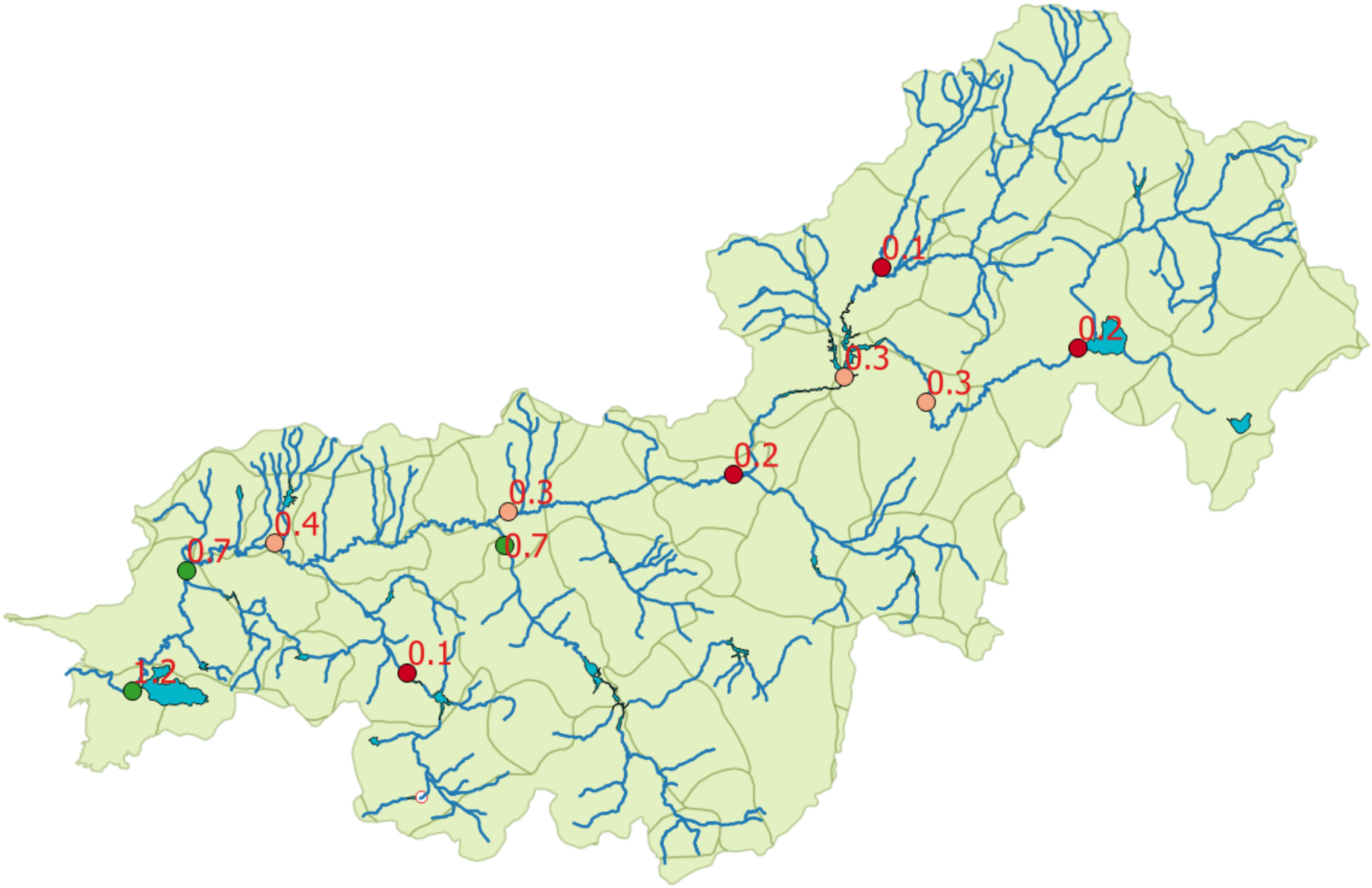
COD: Modeled (2010) vs. Observed (2010)

Factor = Modelled / Observed:

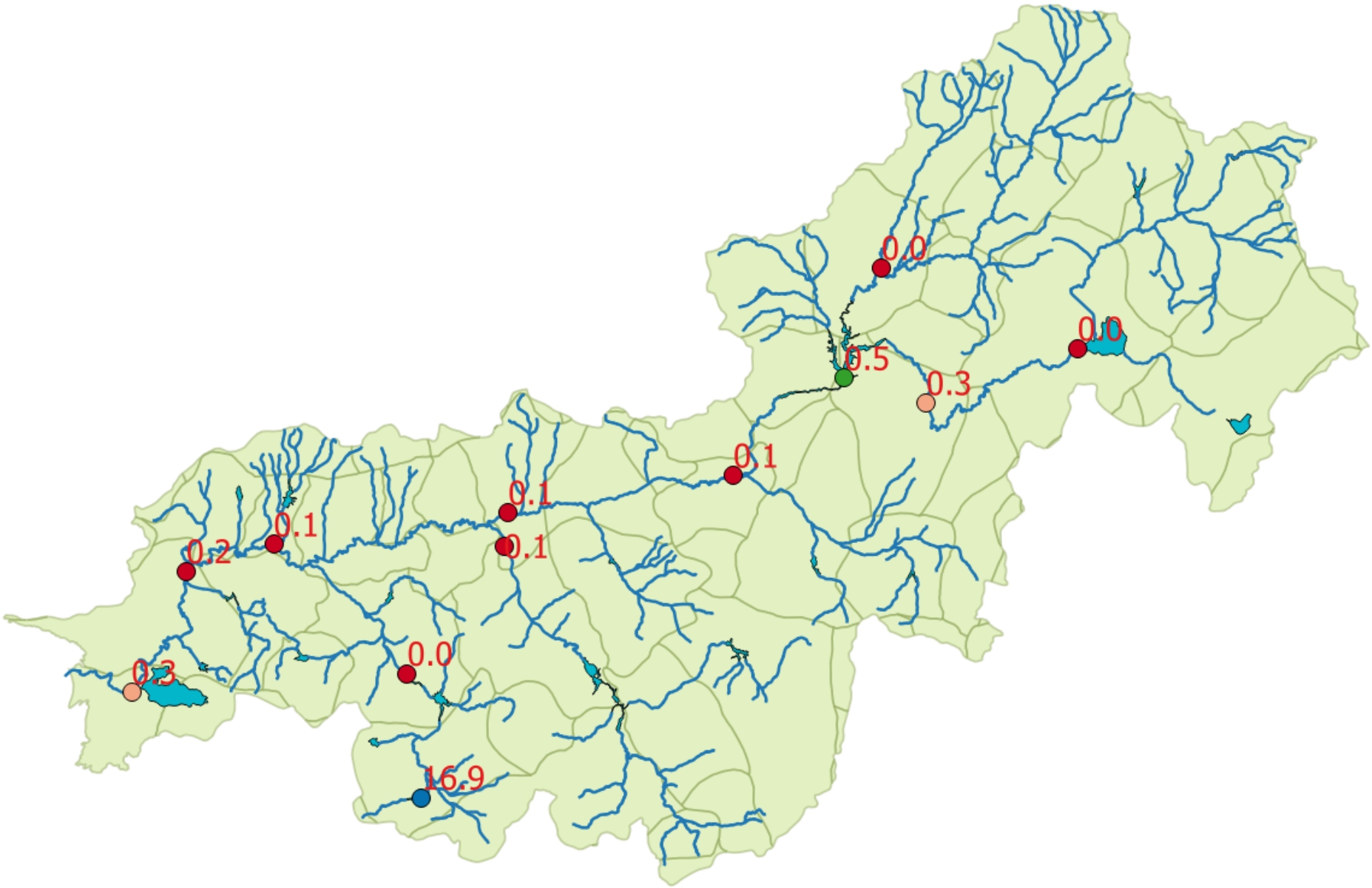
- Green: good aggreement
- Pink: Moderate aggreement (underestimate)
- Red: Bad agreement (underestimate)



TN: Modeled vs. Observed



TP: Modeled vs. Observed



5. Model results (1): WQ and emissions

Overall picture:

- COD:
  - Industrial loads might not be complete.
  - Actual industrial loads might be higher than permitted
- SS
  - Model will underestimate SS load in most locations
  - No SS from diffuse sources → runoff
- TN, TP:
  - Right order of magnitude
  - Compared to data for 2011 - 2014

Recommendations for future projects:

- Add SS to diffuse sources
- Re-asses the industrial loads

Model results (2): Hydrology

Hydrology:

- Reservoir operation will cause very low flow conditions
- Model seems to be very sensitive to low flow conditions → resulting in high concentrations
- RIBASIM does not have effluent discharges of industries and WWTP/sewer systems

Recommendations:

- Add industrial and WWTP/sewer discharges to the RIBASIM model
- Add more detail in catchment inflows (Onur is working on that one)
- Expand hydrology model with data for 2011 – 2014
- Both recommendations are for future development!

8. Ecological Knowledge rules

Baseline - observation

Ecological monitoring
- Species

WFD guidelines

EQR

Bad	Insufficient	Fair	Good	Very good
EQR < 0.2	EQR 0.2-0.4	EQR 0.4-0.6	EQR 0.6-0.8	EQR > 0.8

Report

Ecological knowledge rule → EQR =f(EKF)

Hindcast

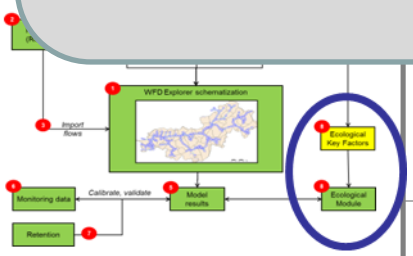
Ecological Key Factors
- WQ parameters
- Hydro-morphological
- Maintenance

?

EQR

Bad	Insufficient	Fair	Good	Very good
EQR < 0.2	EQR 0.2-0.4	EQR 0.4-0.6	EQR 0.6-0.8	EQR > 0.8

Future evaluation (scenario's)



Deltares

Recap last sessions

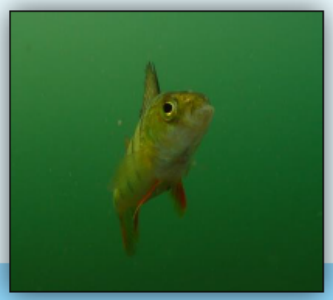
- The RBE uses ecological knowledge rules to predict the effects of measures
- Ecological knowledge rules describe the relation between ecological value and key factors for ecological quality in water bodies

Banks (Ba)
Level Control (L)
Maintenance (Ma)

Total Phosphorus (P)
Total Nitrogen (N)

$$EQR_{fish} = -10.38 + 6.796\ \frac{L^{0.1253} Ma^{0.1178}}{P^{0.03803}} - 0.1405\ \frac{1}{P^{0.4452}}$$

$$+ 4.326\ \frac{P^{0.03148}}{L^{0.2724} Ma^{0.2525} N^{0.01809}} - 0.1624\ \frac{1}{L^{14.87} Ma^{11.67}}$$



Validation PUNN's

watertypes	EQRs					Explaining variables								
	Phythoplankton	Phythobenthos	Macrophytes	Macro invertebrates	Fish	COD	Temperature	Total Nitrates	Total Phosphates	Modifications	Conductivity	Toxic elements	Artificial flow regime	Suspendd solids
Deep lakes (N = 56)	x		X!	X!		x	x	x	x	x	x	x		x
Fast flowing high rivers (N = 34)		x	X!	x	x	x				x		x	x	x
Fast, low and permanent rivers (N=55)		x	X!	x	x	x	x			x		x	x	x
Slow flowing rivers (N=64)		x	x	x	x	x	x	x	x	x	x	x	x	x
Fast, low and temporal rivers (N=33)		x	X!	x	x	x	x			x		x	x	x

X! = no data / not enough data

Validation PUNN's

explaining variable	abbrev.	unit	min	max
COD	COD	mg/l	0	325
Temperature	T	°C	12	75
Total Nitrogen	N_{tot}	mg/l	0	90
Total Phosphorus	P_{tot}	mg/l	0	90
Modification	Mod	-	1	2
Conductivity	EC	µS/cm	10	5000
Toxic elements	Tox	-	1	75
Artificial flow regime	AFR	-	1	2
Suspended Solids	SS	mg/l	0	1900

EQR variable	abbrev.	unit	min	max
Phytobenthos	PhytP.	-	1	20
Phytoplankton	PhytB.	-	0	1
Macrophytes*	MPhy	-	0	1.2
Macro invertebrates	M.inv	-	0	1.2
Fish	Fish	-	0	1

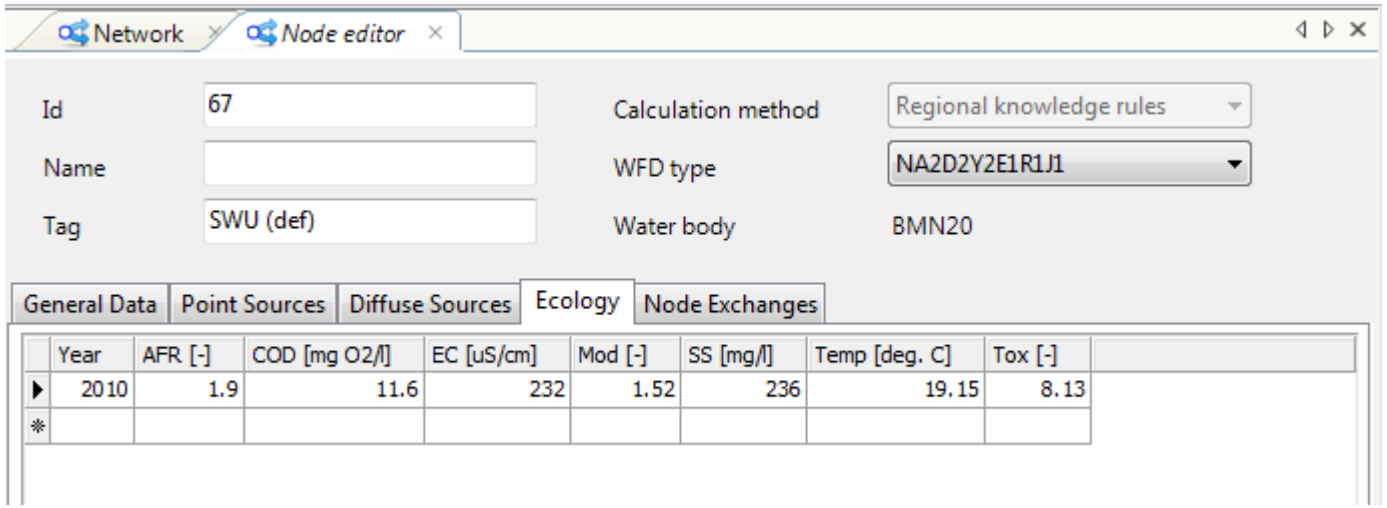
Validation PUNN's: overall preformance

	Phyto-plankton	Phyto-benthos	Macrophytes	Macro invertebrates	Fish
Deep lakes	--				
Fast flowing high rivers		+		+	+
Fast, low and permanent rivers		+/-		+	--
Slow flowing rivers		++	+/-	+	++
Fast, low and temporal rivers		+		++	+

The PUNN's for deep lakes (phytoplankton) and for fast flowing, low, permanent rivers (fish) aren't good enough yet to predict effects of measures.

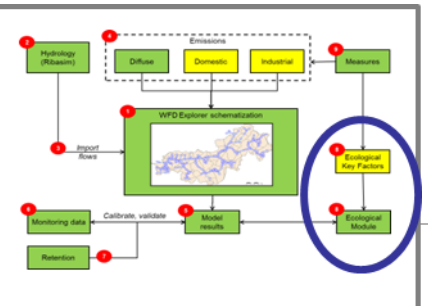
8. Ecological model (PUNN)

Implemented in the WFD Explorer:



More information on PUNN's:

- Presentation M5 by Marieke Fennema, Witteveen+Bos



Deltares

Use of the model in Stakeholder process

Can we use the model → yes

- it will give some answers regarding loads and the effect on the concentrations

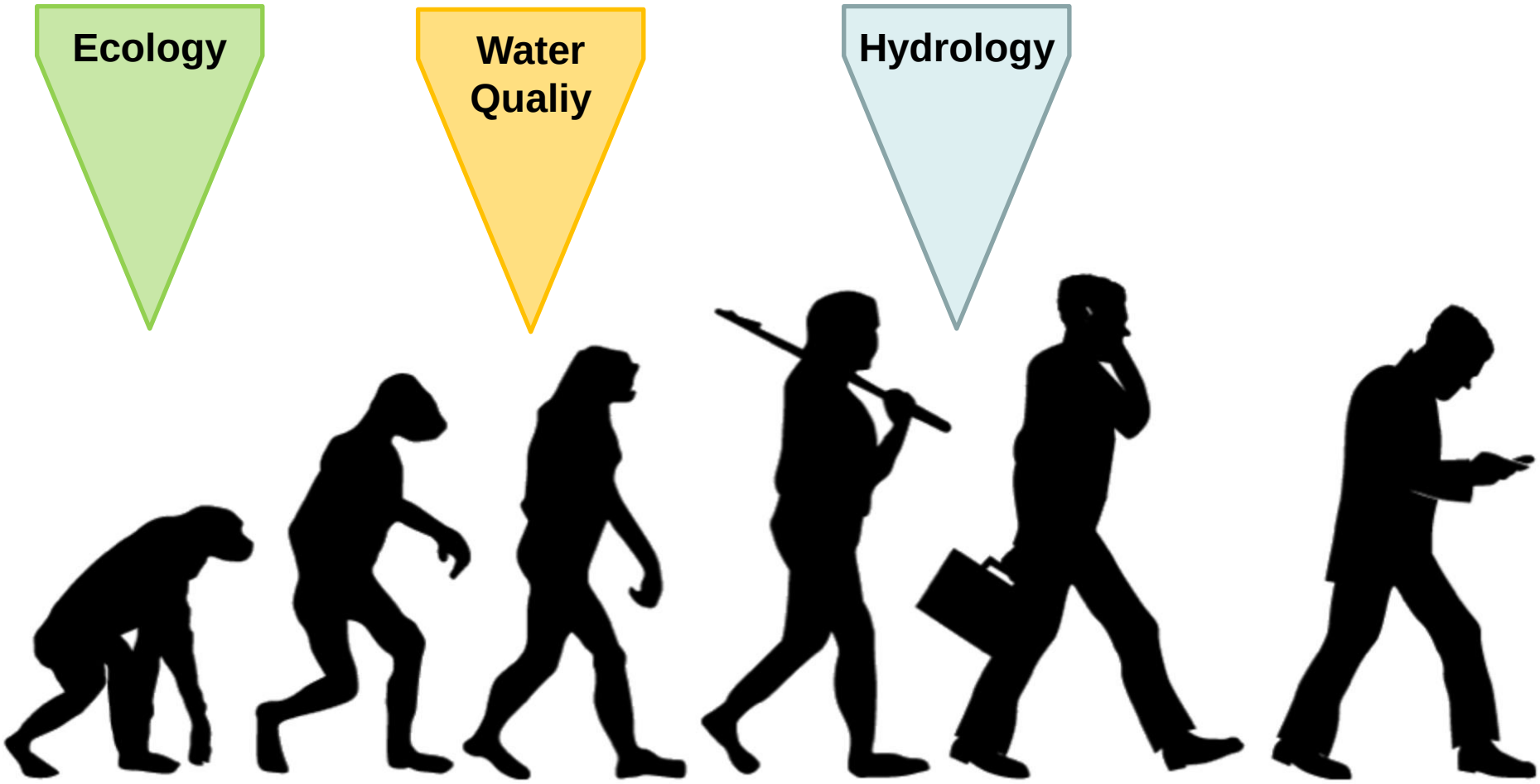
Does it give accurate results regarding concentrations? → no

- Many uncertainties regarding load values and uncertainties in hydrology

Taking measures → yes

- Ecological measures can also be based on WQ data. The PUNN model can run stand-alone in WFD-Explorer interface
- Load reduction measures can also be applied. Relative change of concentrations is also very useful in the stakeholder process

Projection of the used models in evolution



Deltares

Conclusions for the process

- Big accomplishment within the short timespan
- Creating awareness in using models to get more information from data
- Training of staff
- Data availability and access to data is an issue

- Both working groups are aware of these issues

Deltares

Expansion and development

- Short term:
  - Use the model in the stakeholder process
  - Use the modeling concept RBMP project for 4 river basins → data mining → evolve modeling
  - Prepare a follow-up Twinning project , IPA funded
- Med term:
  - Improve models, by gathering data, analysis of data
- Long term:
  - Evolve the ecological model (need for additional monitoring data)