WFD implementation in Temporary Rivers in Cyprus

Gerald Dörflinger
Water Development Department, Nicosia, Cyprus
gdorflinger@wdd.moa.gov.cy
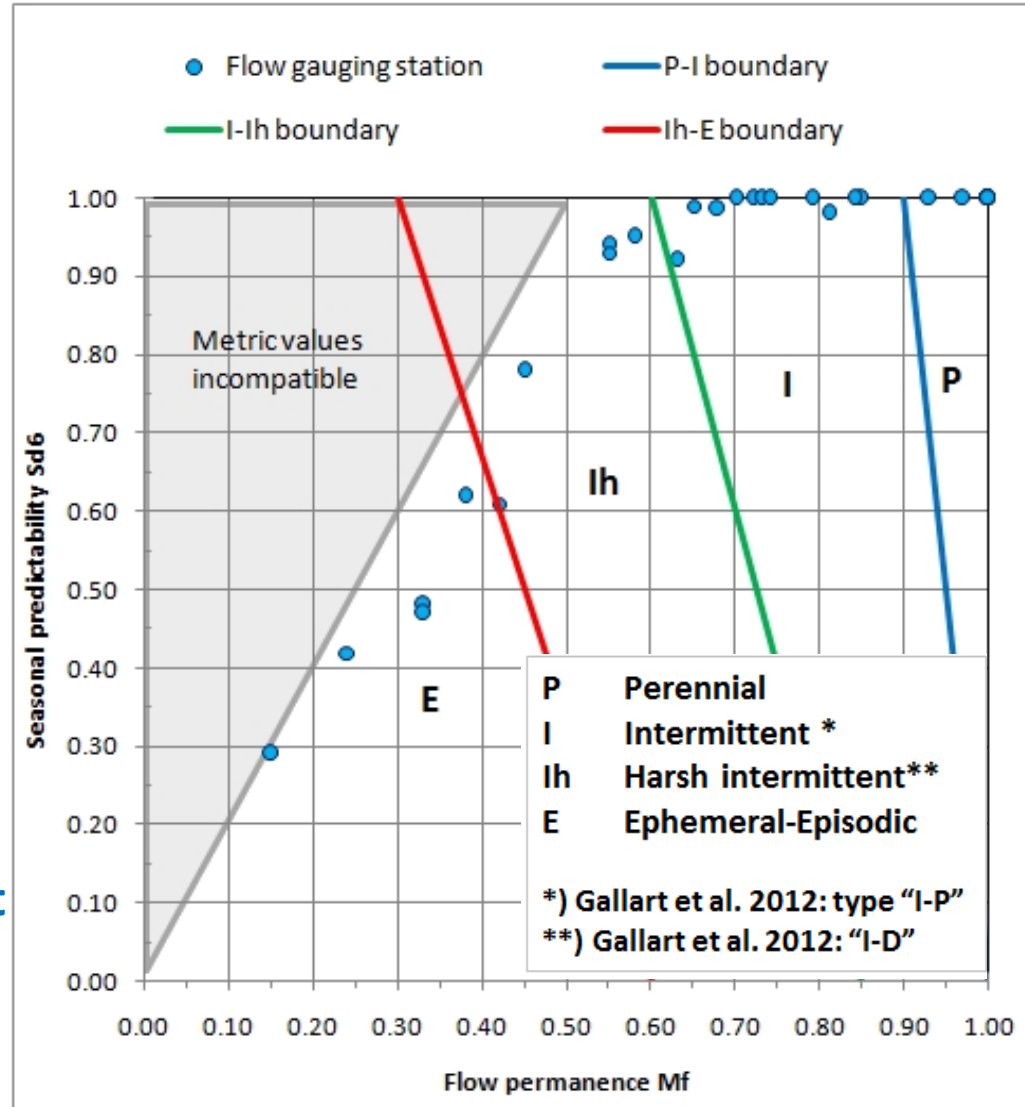
Contents

1) Characterization

2) Monitoring

3) Assessment of ecological status / potential

Characterization – up to 2nd RBMP (1)

- **1st RBMP (2009)**

  - **Temporary rivers were included in the typology**

  - **3 types, of which 2 temporary rivers**

  - **But: there was a <u>lack of knowledge of the key river typology metrics -> types unsuitable to support proper monitoring, assessment</u>**

- **2nd RBMP (2015)**

  - **Development of a new river typology**

    - **Adopted method: Temporary Stream Regime Tool (Gallart et al. 2012)**

    - **Stream types directly relate to the relevance of biological communities for WFD monitoring & assessment purposes (*i.e., intermittent vs. ephemeral/episodic rivers*)**

  - **New typology was complemented by a review of the "identification of water bodies", new mapping of river types, new water body delineation.**

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Characterization – up to 2nd RBMP (2)

- **Recorded stream flow data covered the whole range of flow regimes on TSR plot** (perennial – intermittent - ephemeral/episodic)

- **Characterization of each type by hydrological, flow regime and catchment characteristics was possible**

- **Mapping of river types onto the stream network**
  - **Gauged reaches: Direct stream type assignment**
  - **Ungauged reaches: Assignment using catchment characteristics' criteria and thresholds (data from 29 resp. 77 gauges)**

Legend:
- Flow gauging station
- P-I boundary
- I-Ih boundary
- Ih-E boundary

Metric values incompatible

P   Perennial
I   Intermittent *
Ih Harsh intermittent**
E   Ephemeral-Episodic

*) Gallart et al. 2012: type "I-P"
**) Gallart et al. 2012: "I-D"

Seasonal predictability Sd6 (y-axis)
Flow permanence Mf (x-axis)

Characterization – up to 2nd RBMP (3)

## Benefits and remaining problems of the river typology of the 2nd RBMP

+ **Distinction between the different temporary river types has many benefits**

+ **Type-targeted assessment (intermittent vs ephemeral) and management became possible**

+ **Monitoring could be planned with higher certainty and efficiency**

- **Wrong type assignments**
  - ◆ **Mostly because of local geological conditions (springs)**
  - ◆ **Because of insufficient coverage of some areas/cases with (reference) gauging stations**

➢ **Need to improve stream type mapping**

➢ **Need to identify and map perennial refuges**

➢ *To be achieved by increase of aquatic state monitoring sites*

Characterization – review for the 3rd RBMP (1)

- **Increased number of sites with flow data: 186 individual sites**
  - **82 flow gauging stations**
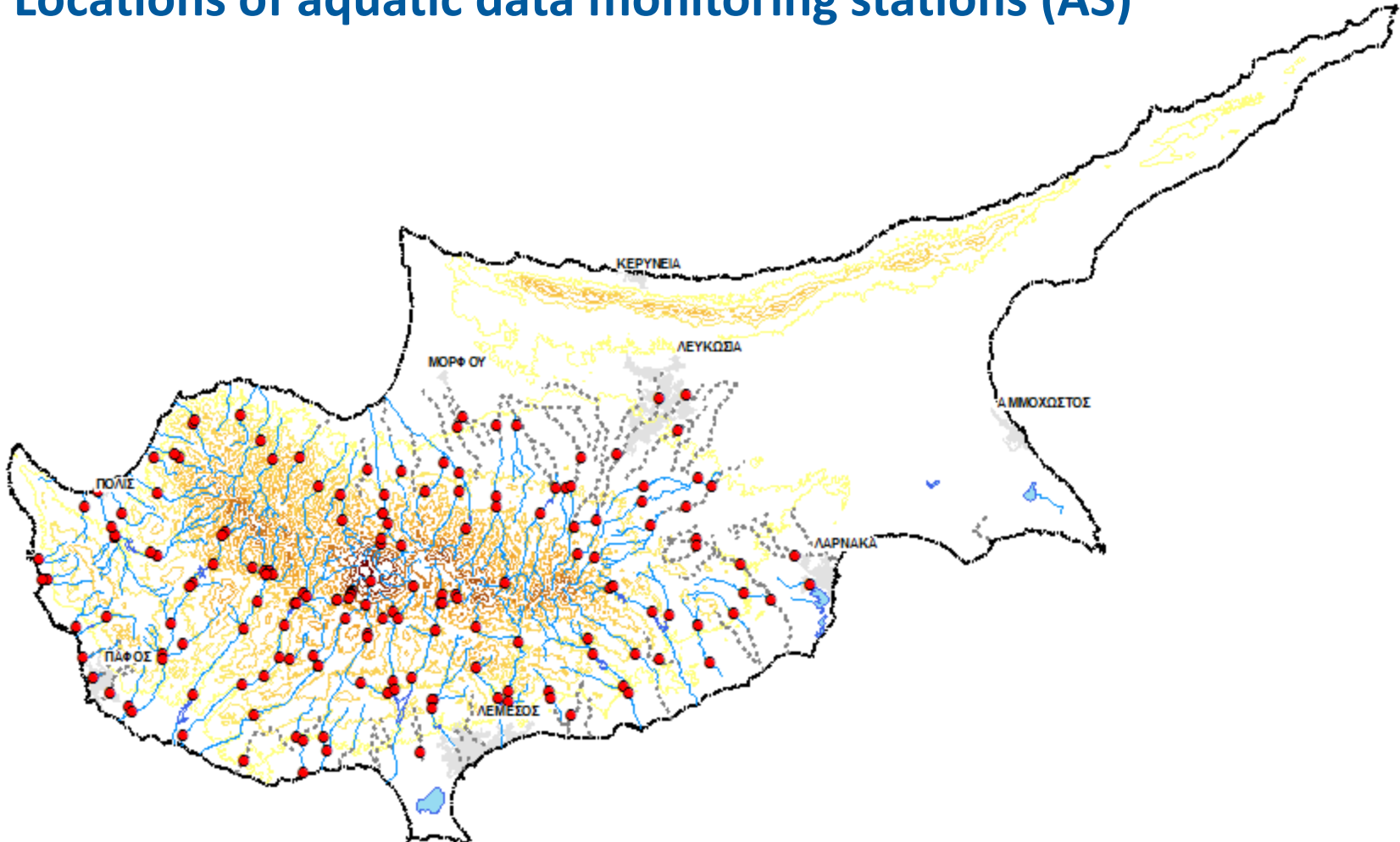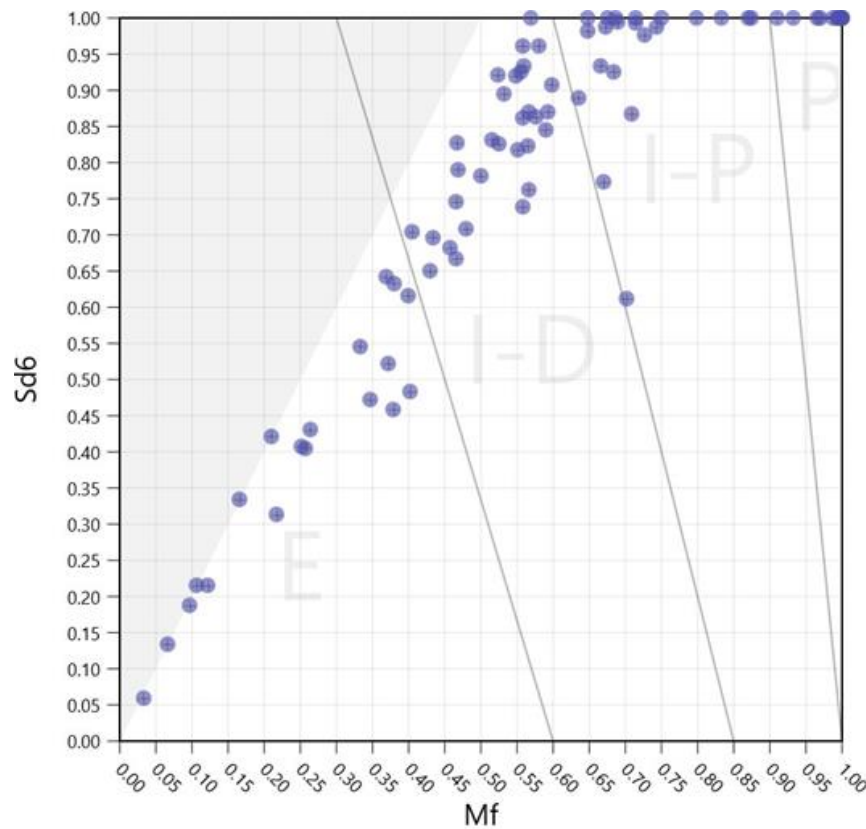 - **104 aquatic state sites**

Characterization – review for the 3rd RBMP (2)

Locations of systematic flow gauging stations
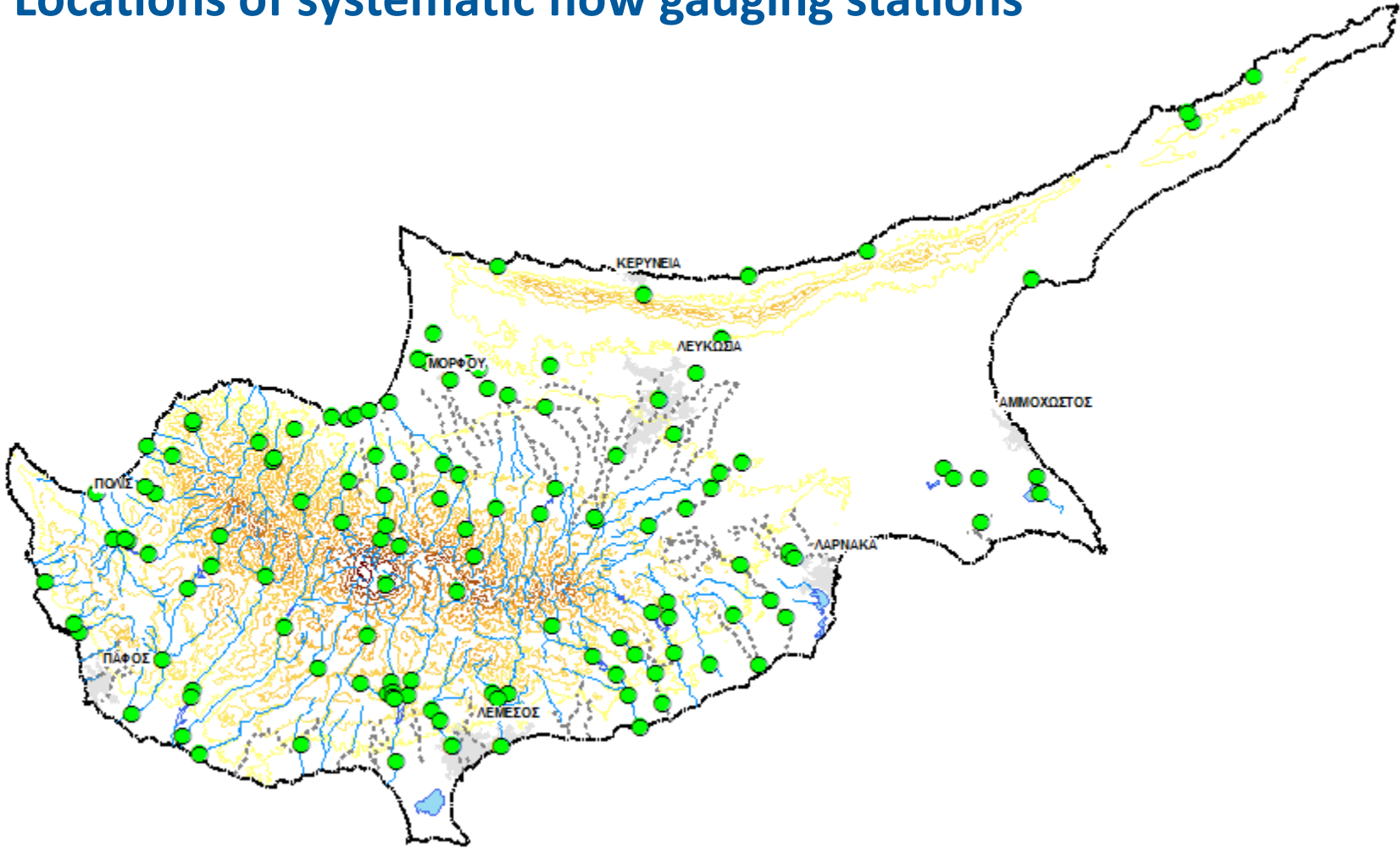
Characterization – review for the 3rd RBMP (3)

Locations of aquatic data monitoring stations (AS)

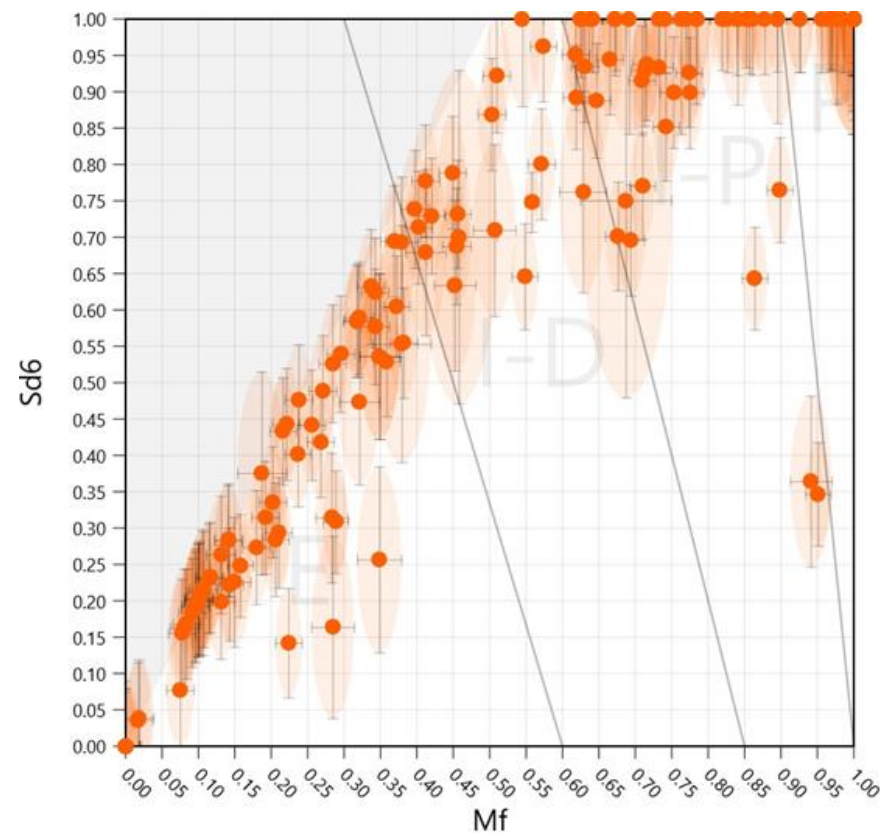# Characterization – review for the 3rd RBMP (4)

- **Increased number of sites with flow data: 186 individual sites**
  - **82 flow gauging stations**
  - **104 aquatic state sites**

- **TREHS software**
  - **TSR Plot was used again, for consistency with the review of the 2nd RBMP**

Characterization – review for the 3ʳᵈ RBMP (5b)

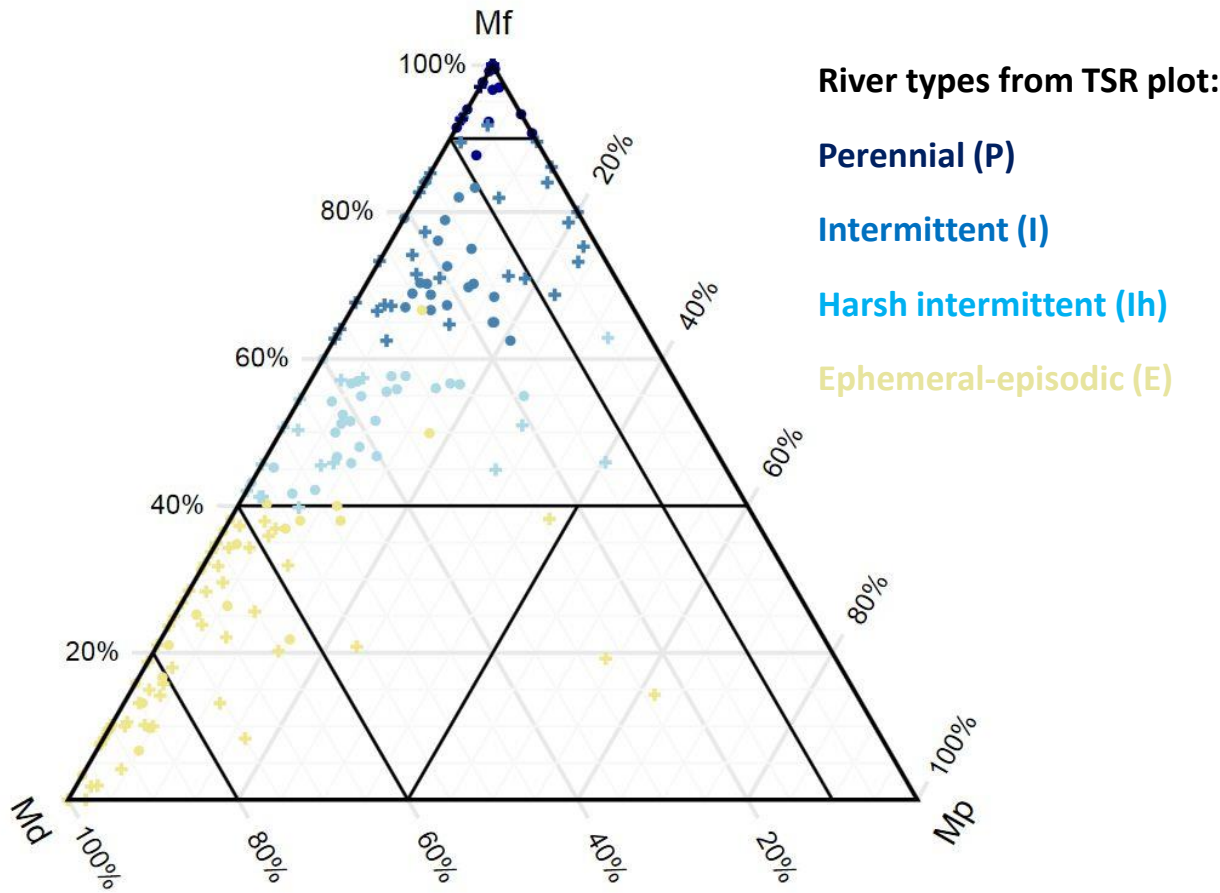**TSR diagram – data from flow gauging stations**

TSR diagram – data from stations with aquatic state data (AS)

Characterization – review for the 3rd RBMP (5b)

TREHS: Types from TSR plot plotted on FDP plot

River types from TSR plot:

Perennial (P)

Intermittent (I)

Harsh intermittent (Ih)

Ephemeral-episodic (E)

FDP (flow-dry-pools) graph showing river flow regimes from 149 monitoring sites in Cyprus (202 timeseries). The colors depict the flow types of these timeseries determined from the TREHS-TRP plot (dark blue: P-perennial, blue: I-intermittent [I-P], skyblue: IH-harsh intermittent [I-D], khaki: ephemeral-episodic [E]). Circles are discharge time series (mean daily flow or monthly spot measurements), crosses are time series of aquatic state. For a number of stations, both series of discharge and of aquatic state exist.
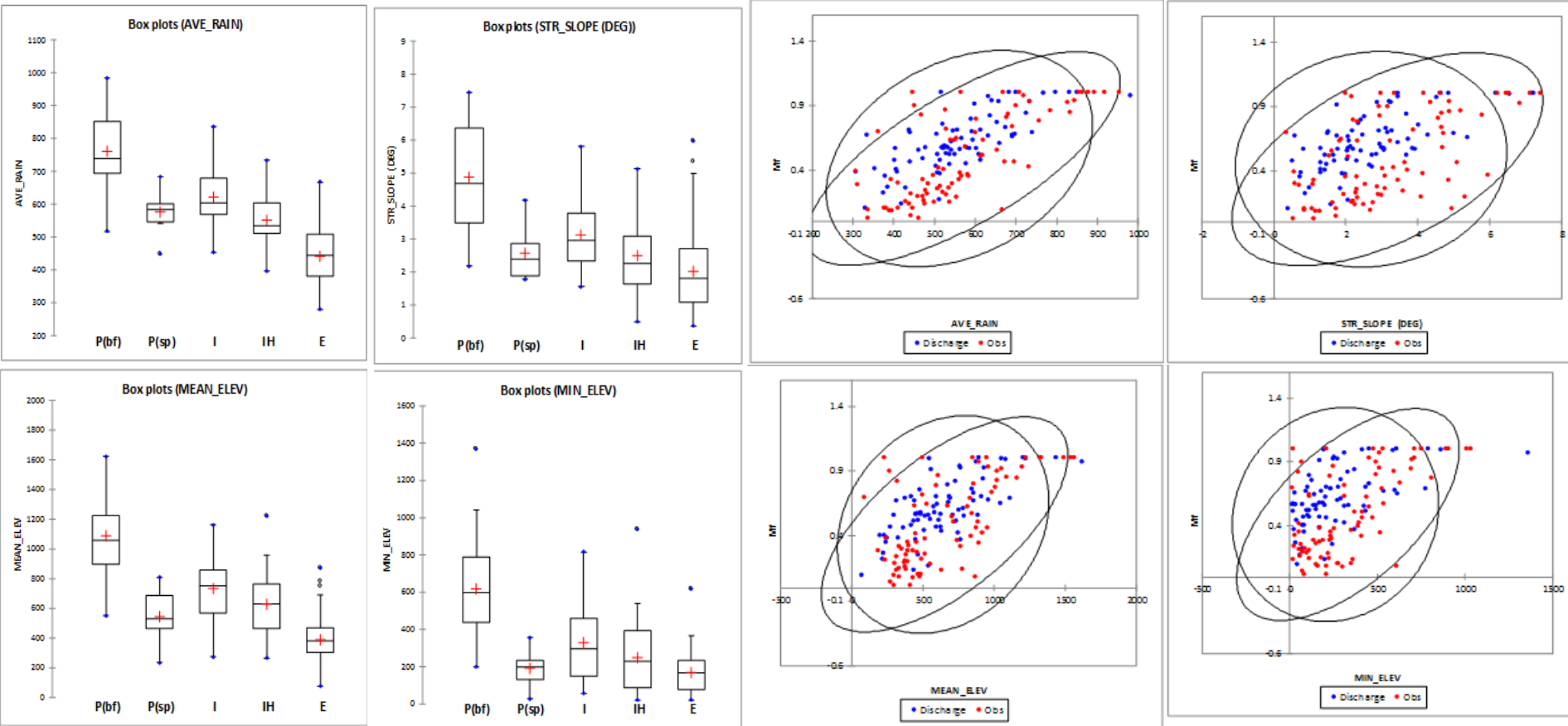
Characterization – review for the 3rd RBMP (6)

- **Increased number of sites with flow data: 186 individual sites**

  - **82 flow gauging stations**

  - **104 aquatic state sites**

- **TREHS software**

  - **TSR Plot was used again, for consistency with the review of the 2nd RBMP**

- **Mapping stream types to water bodies**

  - **Reaches with flow data (gauging station, AS): Direct stream type assignment following a specific procedure**

  - **Reaches without flow data: Multiple linear regression using catchment characteristics (Average annual rainfall, longitudinal gradient of watercourse and mean basin elevation, minimum basin elevation)**

| Results		Model formula	Adjustment indices	
Model	Metric		R^2	Se
Model 1	Mf	Mf = -0,28976 + 0,00146 x AVE_RAIN	0.5377	0.1996
(Flow + AS)	Sd6	Sd6 = -0,08058 + 0,00111 x AREA + 0,01484 x MEAN_SLOPE + 0,00092 x AVE_RAIN	0.5052	0.2159
Model 3	Mf	Mf = -0.02765 + 0.05211 x STR_SLOPE (DEG) + 0.00088 x AVE_RAIN	0.6196	0.1453
(Flow data only)	Sd6	Sd6 = 0.22826 + 0.01686 x MEAN_SLOPE + 0.00060 x AVE_RAIN	0.5813	0.1424

Characterization – review for the 3rd RBMP (7)

Box plots and scatter plots of average annual rainfall, longitudinal gradient of watercourse and mean and minimum basin elevation

Characterization – review for the 3rd RBMP (8)

**River network with river types – 3rd RBMP**
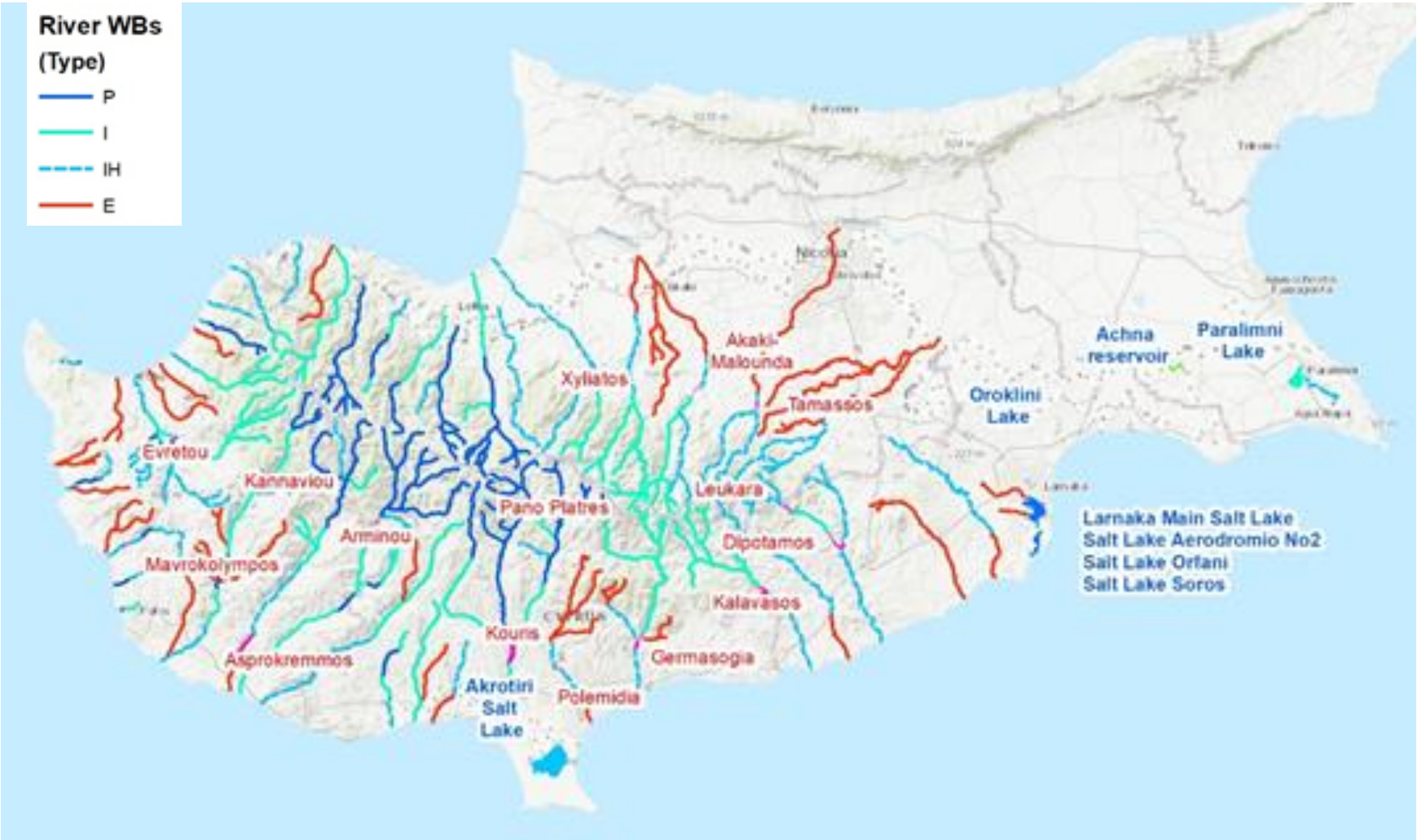
Characterization – 2nd RBMP vs 3rd RBMP

River type	P	I	IH	E	Total
	WFD WB network length (km)				
2nd RBMP	369	692.1	563.5	152.5	1777
3rd RBMP	364.2	528.7	509.9	443.7	1846
	% of WFD WB network length				
2nd RBMP	21%	39%	32%	9%	100%
3rd RBMP	20%	29%	28%	24%	100%
	Number of WFD river water bodies				
2nd RBMP	30	62	56	11	159
3rd RBMP	37	43	53	37	170

Compared to 2nd RBMP

- **Less I and Ih**

- **More ephemeral/episodic**

- **More _small_ perennial WBs: spring-fed refuges**
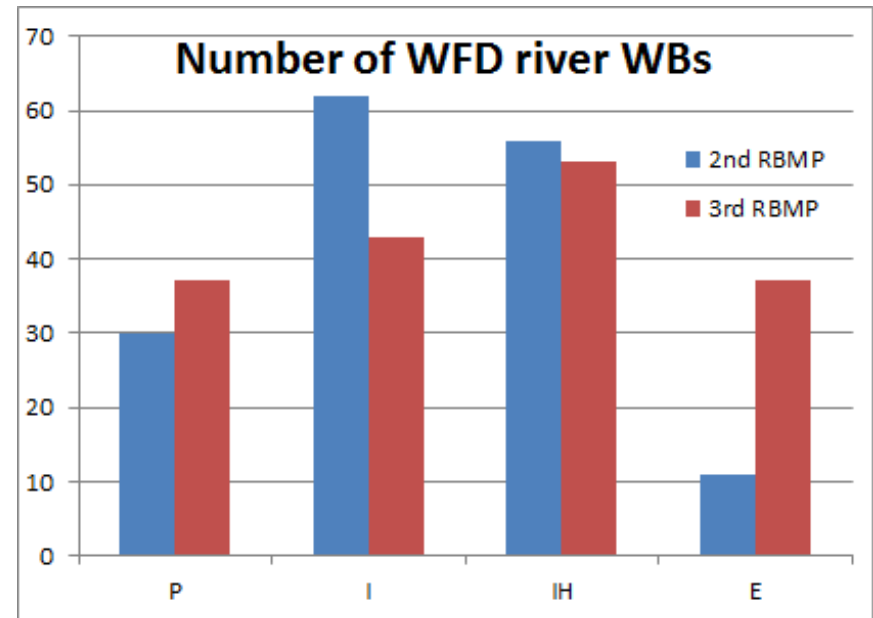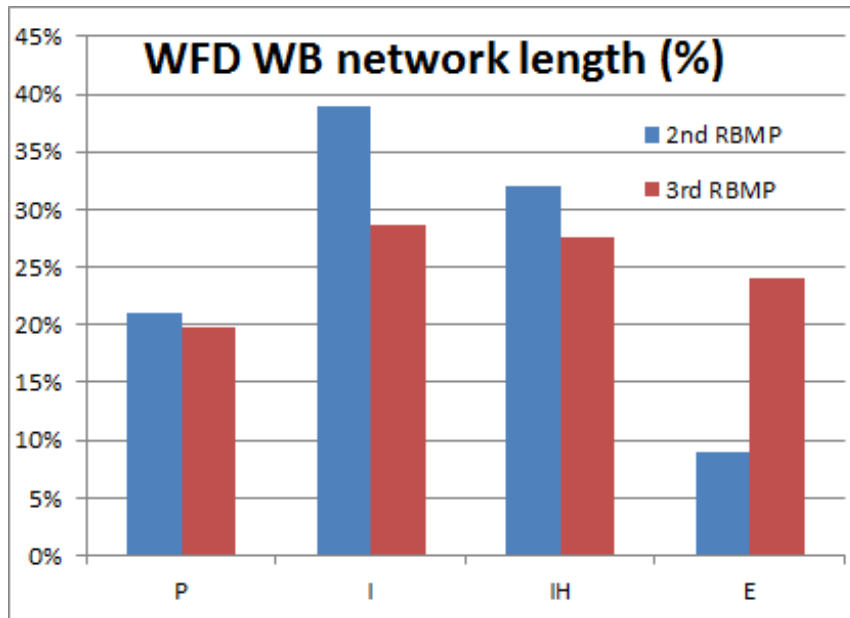
Monitoring – Quality Elements

- **Types I and Ih:**
    - BQEs (Benthic invertebrates & Diatoms)
        - Type I: twice / year
        - Type Ih: once / year (rarely twice)
    - Physico-chemical QEs
    - RBSPs
    - Hymo (IPI index, few sites only)
- **Type E:**
    - Physico-chemical QEs
    - RBSPs
    - Hymo (IPI index, very few sites only)

Monitoring network

- **Total of 147 stations used for status assessment of 3rd RBMP**

River type	P	I	IH	E	Total
	Number of monitoring stations				
	71	26	28	22	147
	48%	18%	19%	15%	100%

Number of monitoring stations
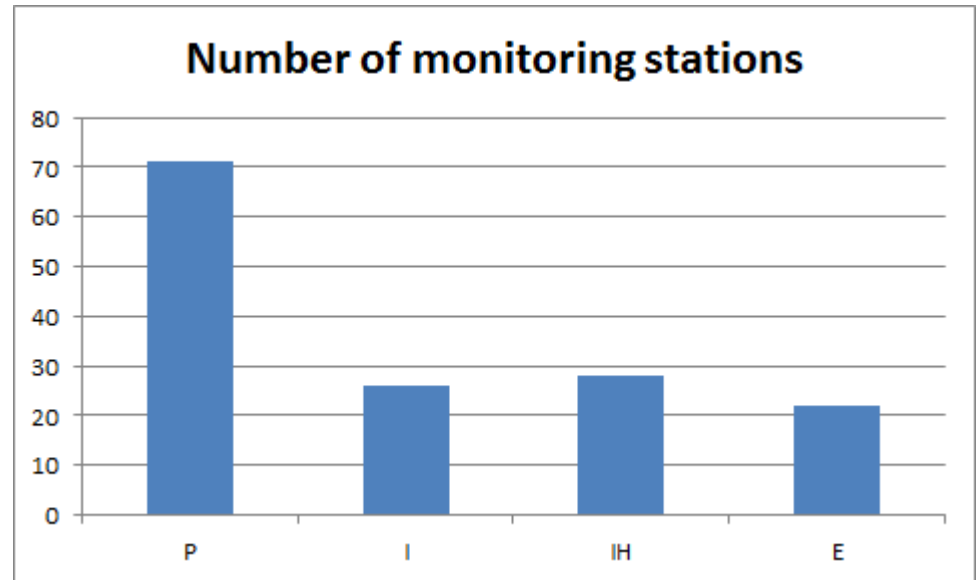
Monitoring – Water body coverage

- **Monitoring coverage:**
  - All types: 88 of 170 water bodies monitored
  - Temporary types: 59 of 133 water bodies monitored
- **Monitoring coverage by type:**

River type	P	I	IH	E	Total
	Number of WFD river water bodies				
Total	37	43	53	37	170
Monitored #	29	18	21	20	88
Monitored %	78%	42%	40%	54%	52%

Number of total and monitored WFD river water bodies by type


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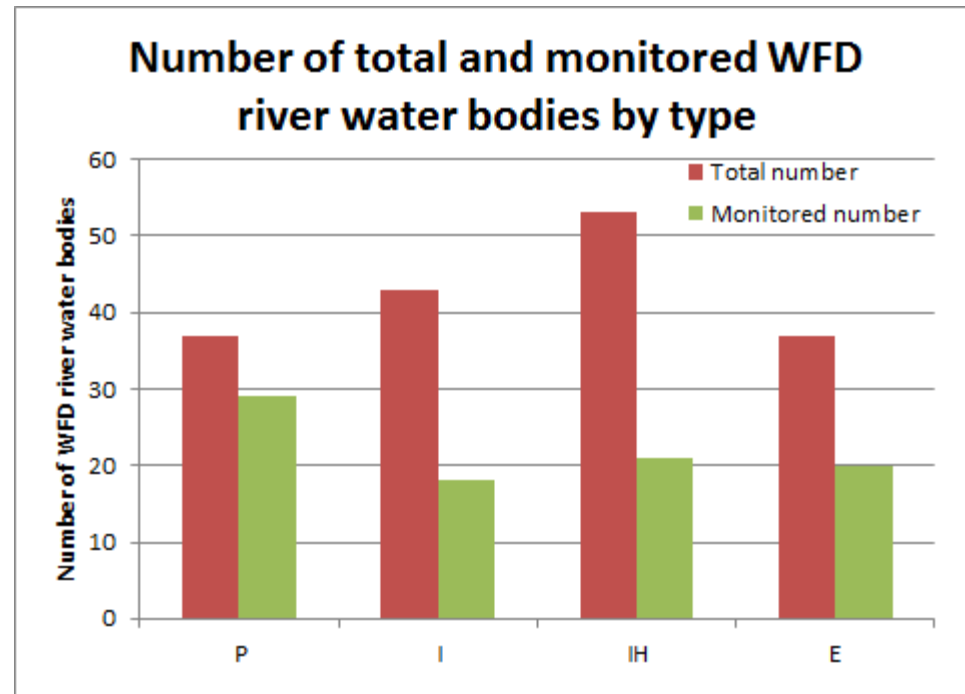
Monitoring - BQEs in Temporary rivers

- Benthic invertebrates: **STAR ICMi index** - Med GIG Intercalibration for R-M5

- Diatoms: **IPS index** - Med GIG Intercalibration for R-M5

- Macrophytes: Data collection ongoing, but MMI (Multimetric Macrophytes Index, not intercalibrated) is not used for status assessment

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Assessment of status – Results
Ecological status / potential of river water bodies

	P	I	Ih	E	TOTAL
	No. of Water Bodies				
HIGH	2	6	0	1	9
GOOD	20	19	26	22	87
MODERATE	13	17	25	13	68
POOR	2	1	2	1	6
BAD	0	0	0	0	0
TOTAL	37	43	53	37	170
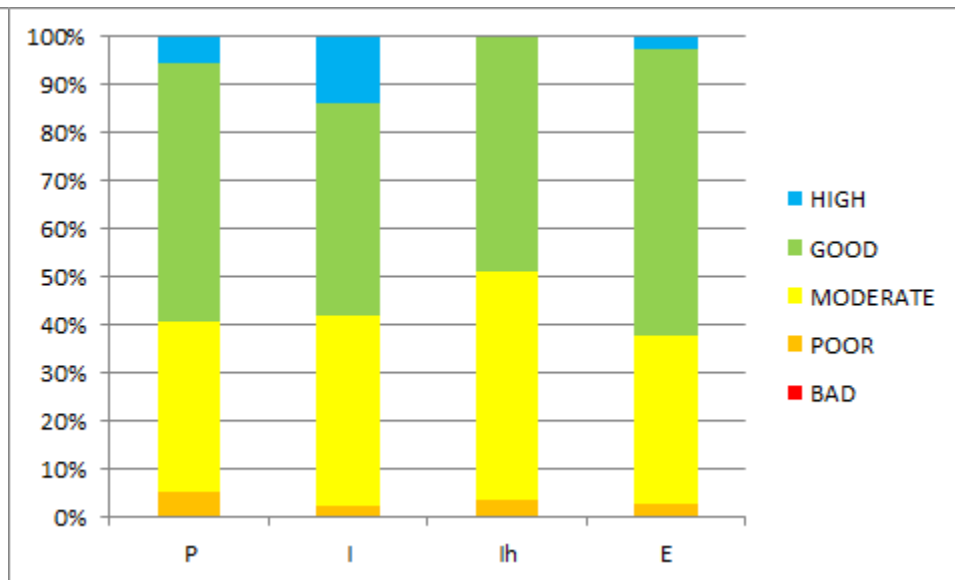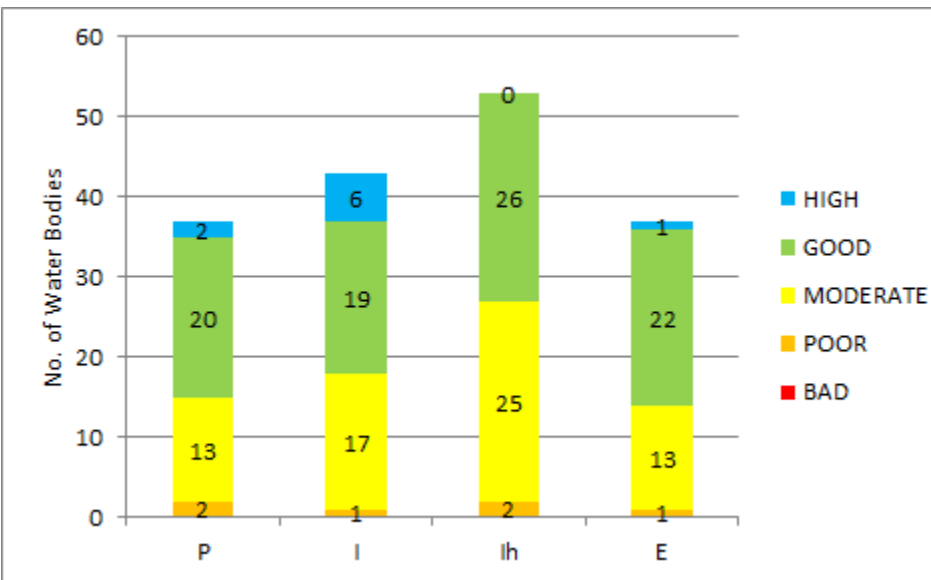
Main issues - Conclusion

Characterization

Incremental improvement with Art.5 review of each RBMP. With today's knowledge, we expect only "fine tuning" to be necessary.

Monitoring

- Efforts to expand monitoring to more temporary water bodies

- HYMO gap: 3rd attempt is ongoing to find contractor for method development. HYMO method is especially crucial for ephemerals

- Macrophytes? is it worthwhile? Are any efforts planned elsewhere?

Assessment

- HYMO gap - see above

- Macrophytes - see above

Thank you for your attention

Questions?

Gerald Dörflinger
Water Development Department, Nicosia, Cyprus
gdorflinger@wdd.moa.gov.cy