SMIRES - Science and Management of Intermittent Rivers & Ephemeral Streams
4th MC meeting and combined WG meetings
Budva, Montenegro, October 3rd & 4th 2018

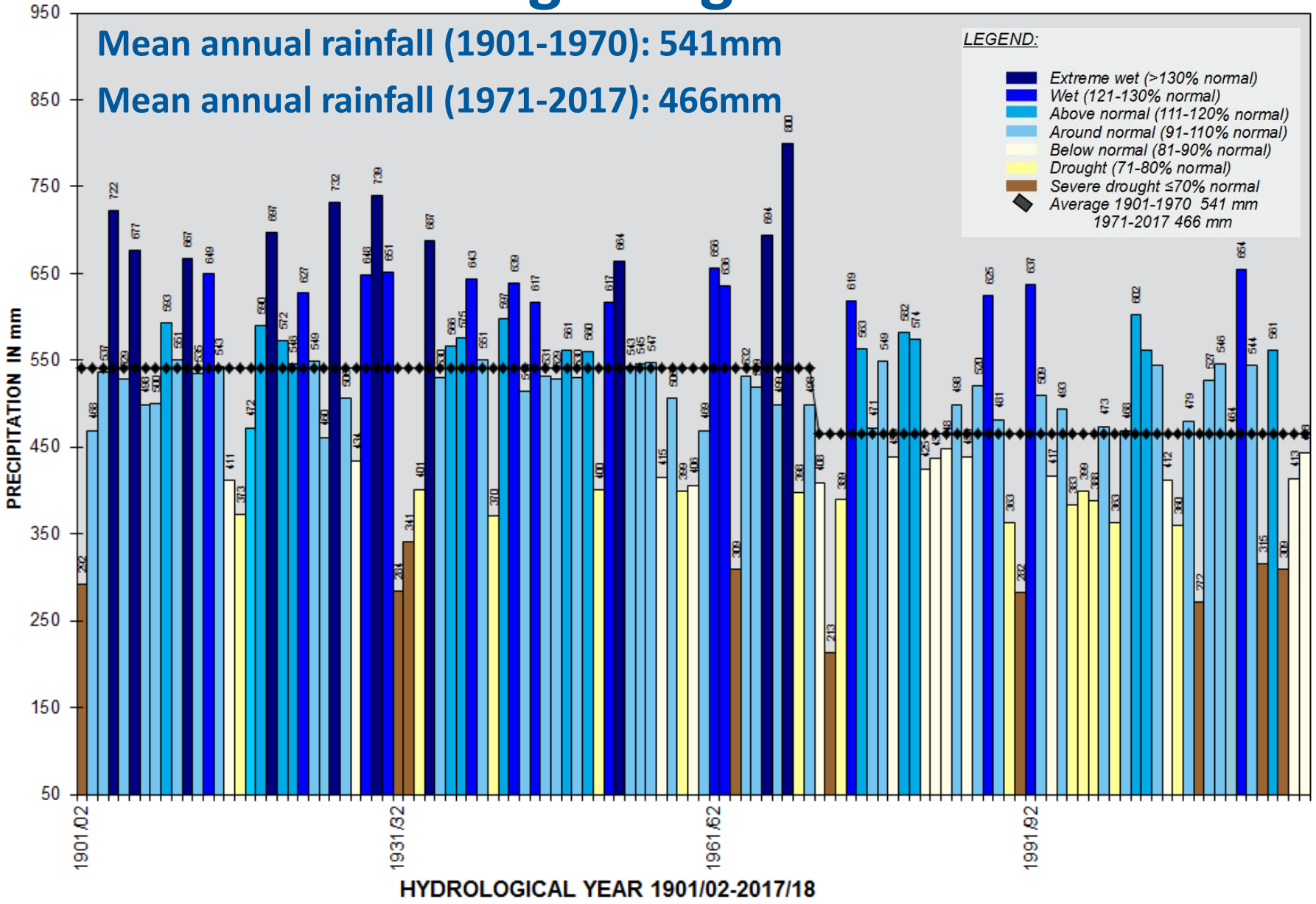
E-flows in Cyprus - an overview

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

Presentation outline

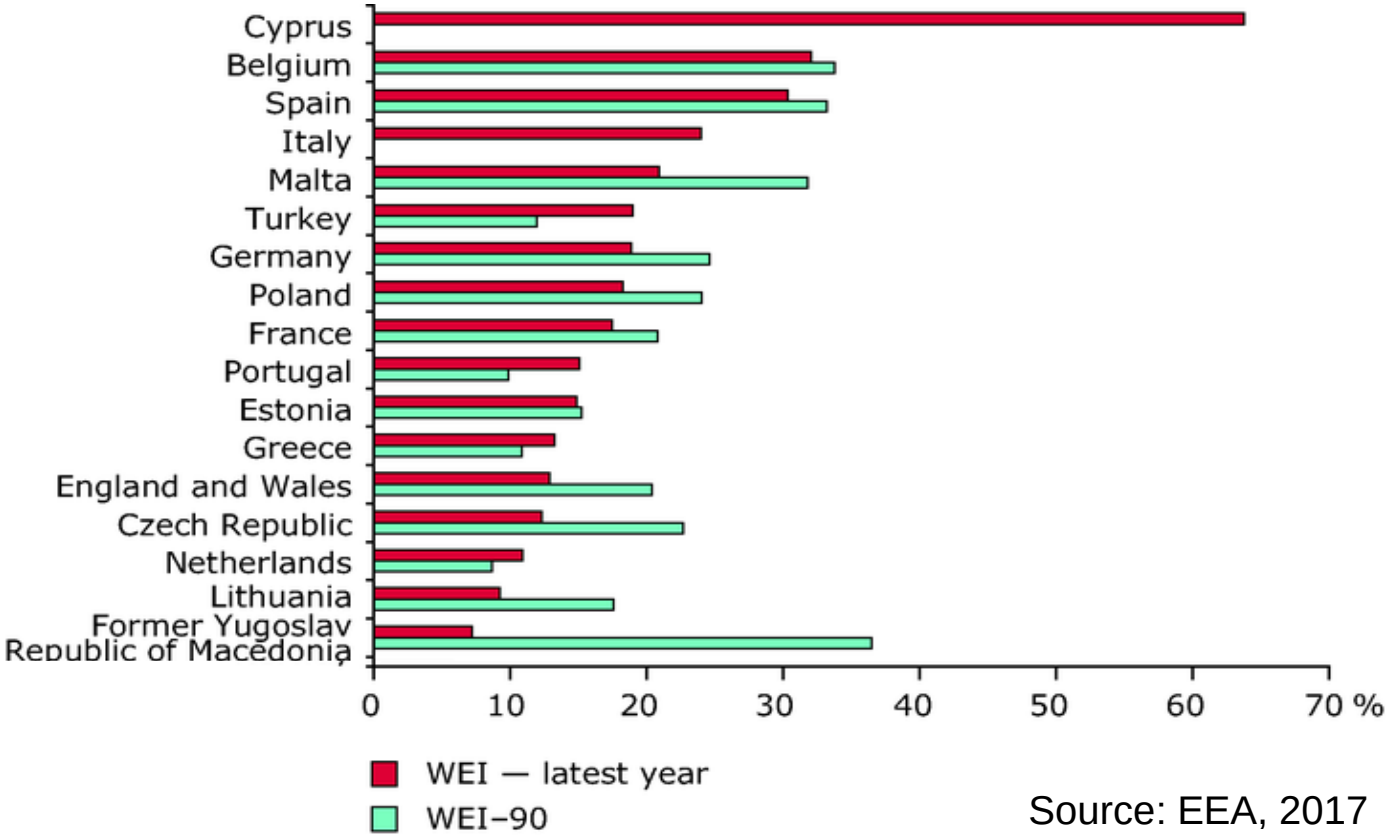
- Hydrological framework conditions
- Cases where E-flows are considered:
  - (Large) dams → WFD
  - Stream diversions and small dams → National legislation
- Utilization / services of Cyprus rivers
- E-flows under the WFD (large dams)
- E-flows under the national legislation (stream diversions, small dams)
- Challenges/problems

Hydrological framework conditions (1)
Rainfall … getting less and less



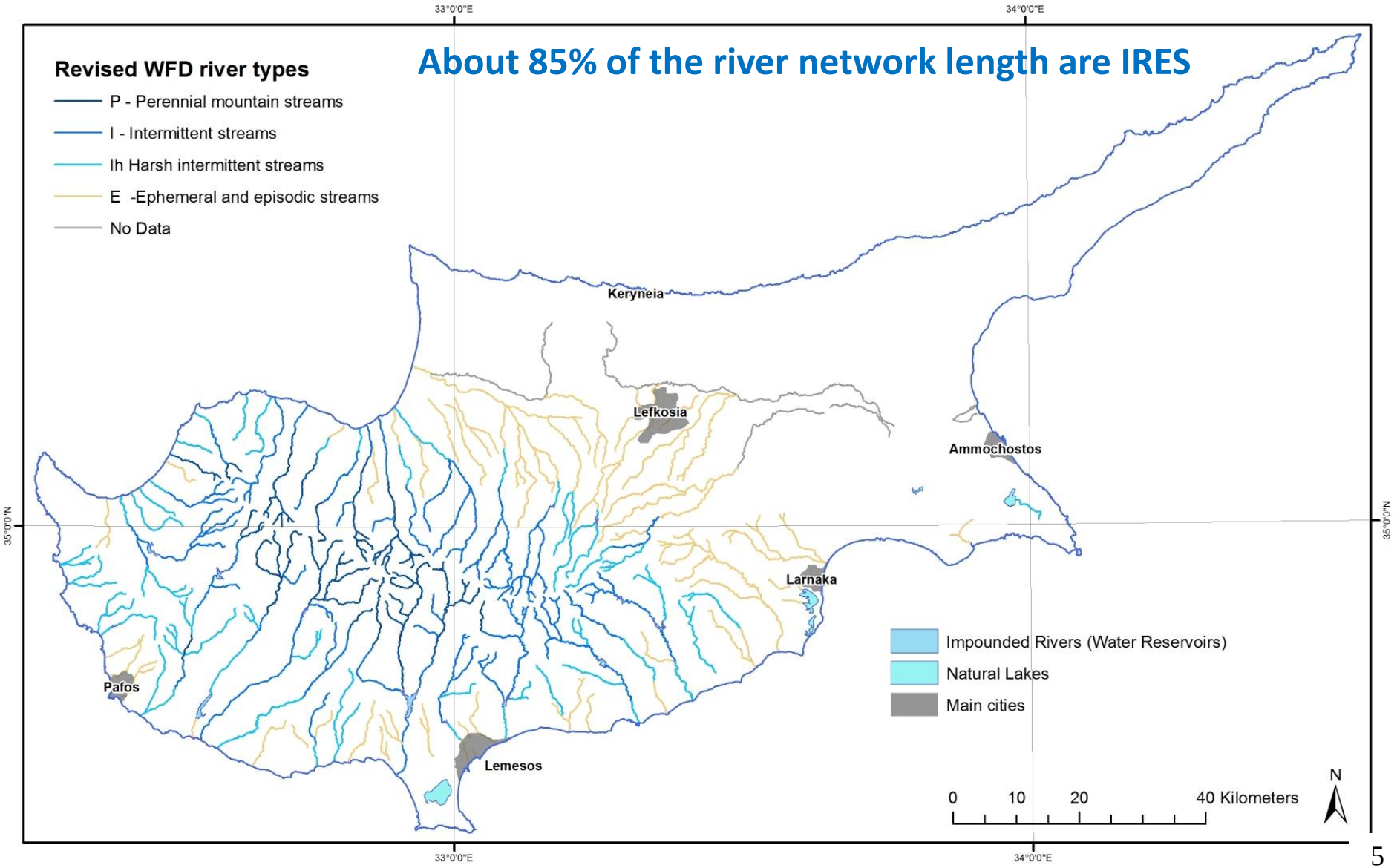
Hydrological framework conditions (2) Water Exploitation Index

- Cyprus is a water scarce country
- A Water Exploitation Index (WEI) index of over 20 % usually indicates water scarcity



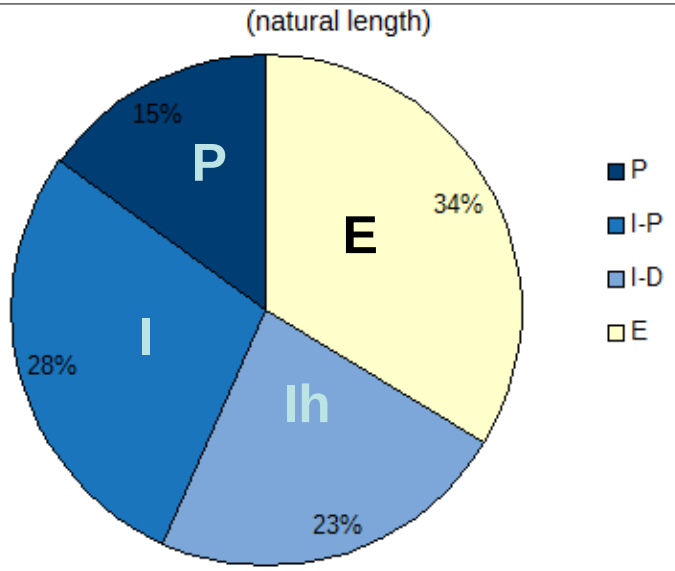
Source: EEA, 2017

Hydrological framework conditions (3a)
River flow regimes / river typology



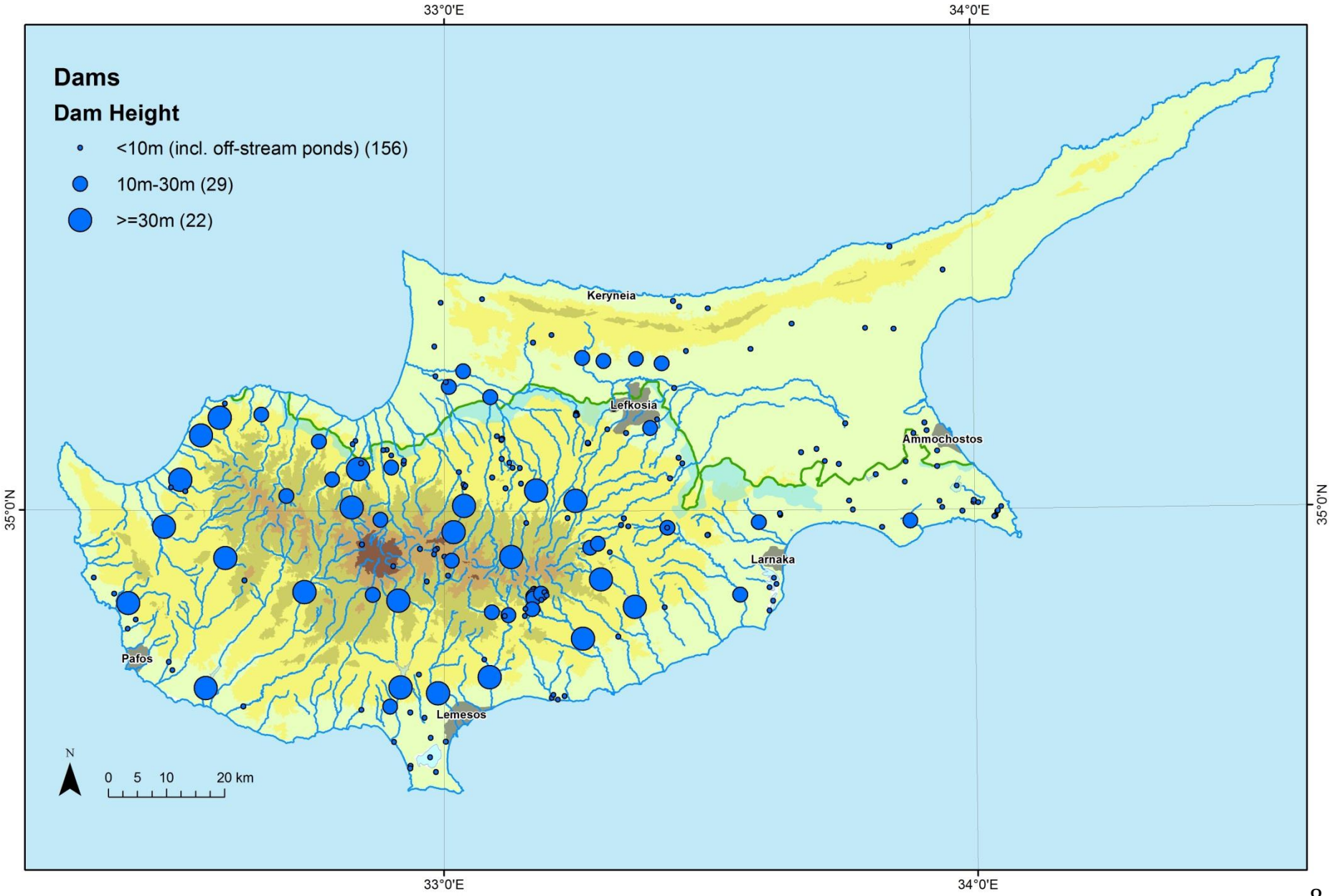
Hydrological framework conditions (3b)
River flow regimes / river typology
River network length

River type	Perennial P	Intermittent I	Harsh Intermittent Ih	Ephemeral/ episodic E	Total
Natural length [km]	369.0	692.1	563.5	825.5	2450.1
% of total natural length	15%	28%	23%	34%	100%



Dams in Cyprus

Dams in Cyprus

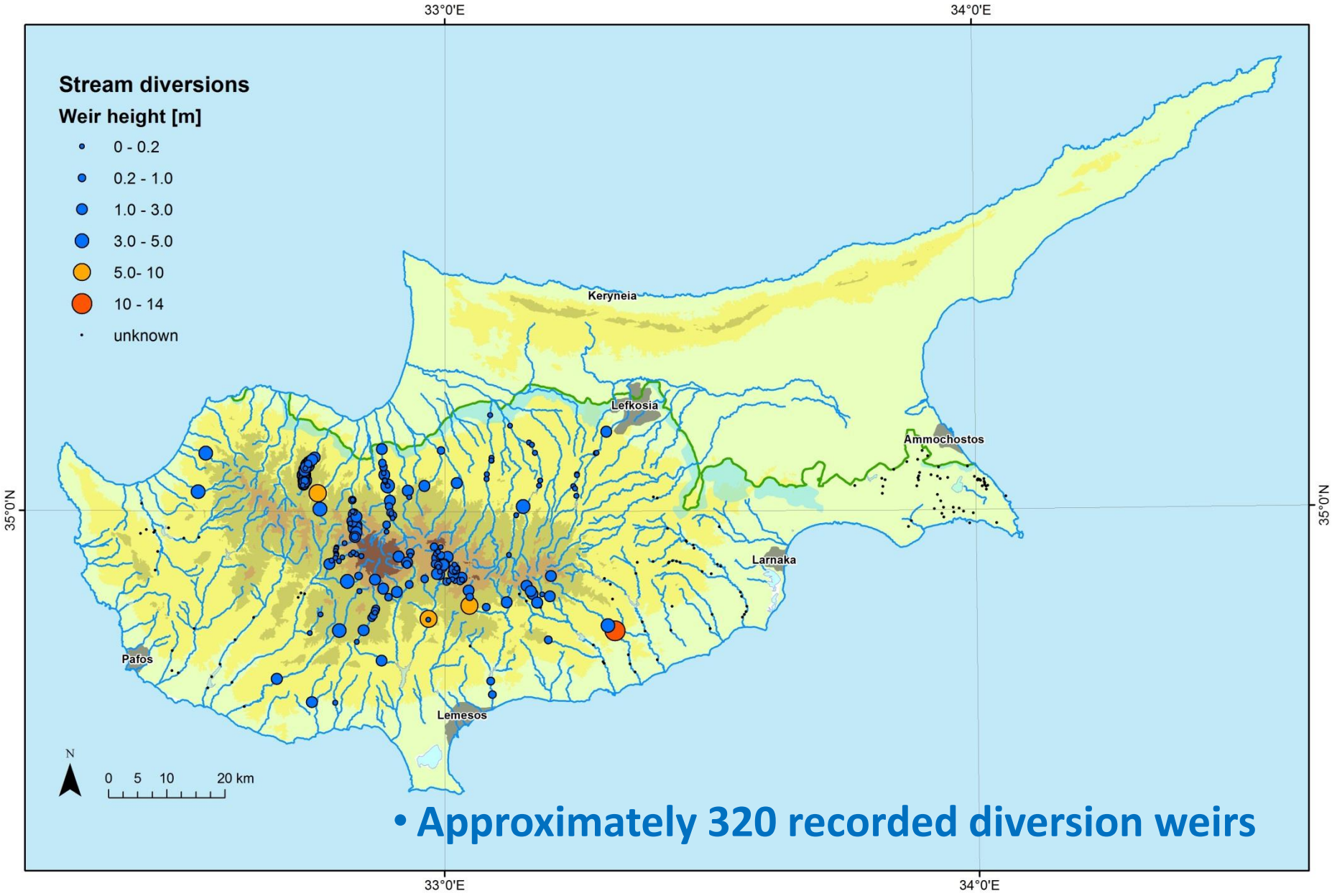


Dams in Cyprus

- A great number of dams:
  - 22 dams with height >=30m
  - 29 dams with 10-30m height
  - 156 smaller dams (incl. off-stream ponds)
- Almost all significant rivers are “dammed”
- Dams were constructed from the late 1940s onwards, most storage capacity was built in the 1980s
- Dams were not designed to release e-flows
- Reservoir water uses: domestic water supply and irrigation, no hydropower dams
- Flow releases downstream of dams “pre-WFD”:
  - Implemented for few dams only, on a case by case basis
  - Purpose: aquifer recharge d/s of dam to sustain groundwater abstraction & flow preservation for environmental purposes.

Diversion weirs in Cyprus

Diversion weirs in Cyprus



- Approximately 320 recorded diversion weirs

Diversion weirs in Cyprus

- Approx. 320 recorded stream diversion weirs
- Mostly on mountain rivers which have dry season flow
- Many were built in the 1940s and 1950s
- Structures are not designed to release e-flows
- Operated mainly by Irrigation Divisions (Legal entities supervised by the District Officer), few by fish farms
- Operation under old regulations
  - No provision for e-flows
  - Allowed diversion volume is not specified and mostly not measured
- High irrigation demand in summer when river flows are at their minimum -> all water is diverted in many cases
- The income of the farmers of the Irrigation Divisions is low
- Decline of mountain farming: structures are being abandoned

Utilization / services of Cyprus rivers

- Rivers are mostly perceived and used as a source for water abstraction for domestic water supply and irrigation
- Environmental value of rivers is recognized where river corridors are protected for e.g. Birds and Habitats Directives
- Fish
  - Only one autochthonous fish species in Cyprus rivers (European eel, *Anguilla anguilla*)
  - In the past, the eel was part of the diet in villages nearby of rivers
  - Angling in rivers was never widely popular -> no angler's lobby
- Rivers as recreational areas have no tradition
  (one possible reason: "unspoilt" perennial rivers are in remote areas, they are small, and access is often [very] difficult)

E-flows under the WFD 2nd RBMP in Cyprus (1a)

- 15 dams/water reservoirs were provisionally designated as "impounded river" HMWBs for WFD purposes
- Outcome of HMWB designation tests 7-9, for all 15 dams/reservoirs:
  - E-flow for restoration of GES was determined as 60% of mean annual natural runoff
  - The water resources of Cyprus are marginally sufficient for water supply and practically insufficient for irrigation
  - The release of the above-mentioned restoration e-flow would have extremely adverse effects on irrigation and/or water supply incl. tourism
  - Other means to meet water supply and irrigation needs are virtually insignificant, because all possible measures have already been taken (water saving, advanced irrigation technology)

E-flows under the WFD 2nd RBMP in Cyprus (1b)

- Based on HMWB designation tests 7-9, all 15 dams/water reservoirs were designated as Heavily Modified Water Bodies
- E-flows were included as mitigation measures for achievement of the environmental objective i.e. GEP
- Three types of e-flows depending on dam/reservoir:
  - "Simple" release into the riverbed d/s of the dam
  - Targeted release at specific sites and/or reaches d/s of the dam
  - Flushing flows
- The National Drought Management Plan regulates the actual e-flow releases of each year depending on actual storage in the reservoirs
- The e-flow release volumes will result in improved downstream ecosystems as far as possible, without significant adverse effects on water uses.

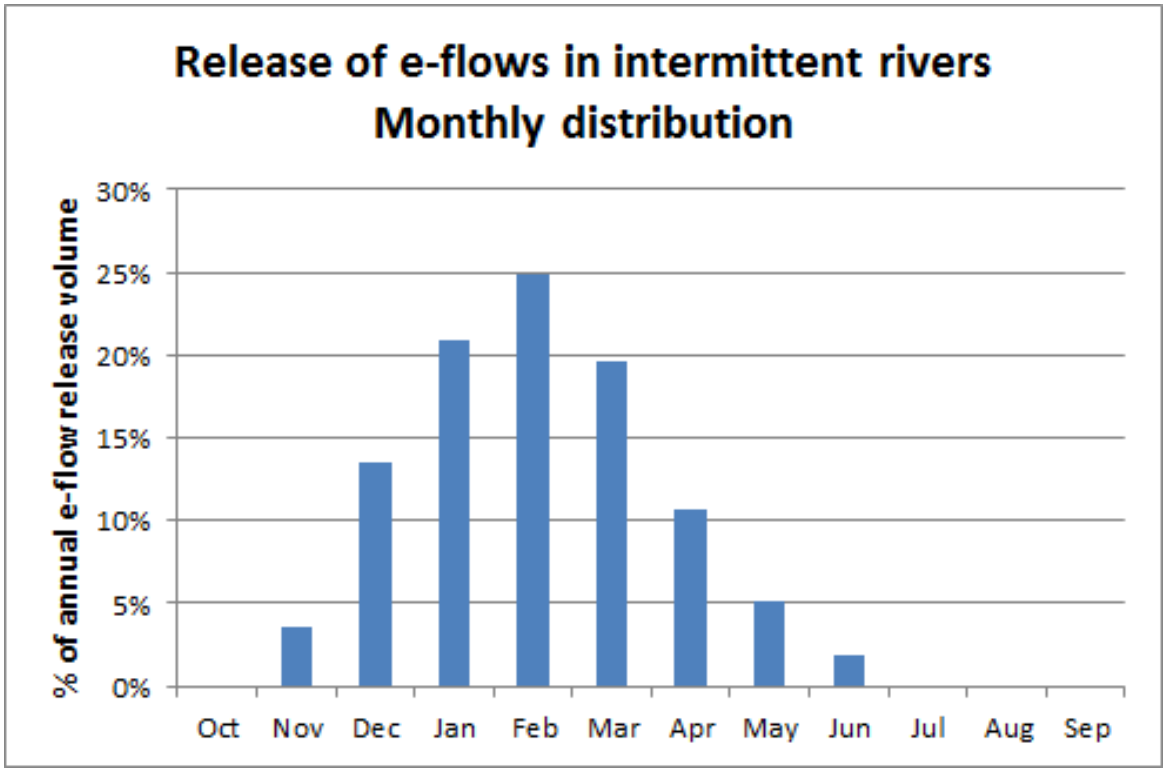
E-flows under the WFD 2nd RBMP in Cyprus (2)

- **Mean annual e-flow release volumes (2nd RBMP):**

Reservoir	Mean annual inflow [10^6M3]	"Simple release"	Targeted release	Flushing flow	Annual eflow release volume [10^6M3]
Arminou	18.9	YES	YES	-	2.0
Kouris	38.4	YES	YES	YES	2.0
Germasogeias	14.7	YES	-	YES	4.9
Kalavasos	7.4	YES	-	-	0.6
Lefkara	1.9	YES	-	YES	0.1
Dhypotamos	5.3	YES	-	YES	0.5
Kannaviou	5.1	YES	YES	YES	0.5
Xyliatos	2.2	-	-	YES	covered by dam spillages
Evretou	7.1	-	YES	-	0.15
Argaka	2.6	-	-	YES	covered by dam spillages
Ag. Marina	0.8	-	-	YES	covered by dam spillages
Tamassos	6.3	-	-	YES	covered by dam spillages

E-flows under the WFD 2nd RBMP in Cyprus (3)

- **Monthly distribution of E-flow releases was derived from natural river flow regime:**



E-flows under the WFD 2nd RBMP in Cyprus (4)

- The National Drought Management Plan specifies the actual e-flow releases of each year
- The actual e-flow releases in each year depend on the water stored in the reservoirs on the 1st of October, 1st of January and 1st of April
  - Actual storage >= mean storage -> release entire e-flow volume
  - 15% < actual storage < mean storage -> reduce e-flows analogous to actual storage
  - Actual storage < 15% of mean storage -> stop release of "simple" e-flows, reduce targeted e-flows
- During the last years, due to the continued droughts and the subsequent small storage in the reservoirs, e-flows were released from two dams only.

E-flows from diversion weirs & small dams

- Regulated under the Integrated Water Management Law (N.79(I)/2010)
- The Law does not mention ecological flows explicitly, but provides instruments to impose them.
- The Law prohibits any water abstraction except when permits for the Water Impoundment Project (i.e. the construction works) and for the Water Abstraction itself are obtained beforehand.
- The responsible authority can include any conditions and restrictions deemed necessary in the permits, including the releases of ecological flows.
- The procedures for issuing the above permits have started recently, few cases with e-flows requirement by now

Collection of challenges/problems

- Very high degree of water exploitation leaves very little leeway for releasing e-flows
- Lack of lobbies for aquatic ecosystem
- Lack of (human) resources in the responsible Authorities
- Dams built without intention to release e-flows -> E-flows implementation is limited by the existing outlets/washouts of each dam
- The income of the farmers of the Irrigation Divisions is usually low → difficult to impose construction works on the structures to allow for e-flows (or for measuring diverted water volume)

Thank you for your attention

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