Council for Development and Reconstruction (CDR)
Ministry of Energy and Water (MoEW)
Water Establishment Beirut and Mount Lebanon (WEBML)

Federal Institute for Geosciences
and Natural Resources (BGR),
Hannover, Germany

German-Lebanese Technical Cooperation Project

Public Awareness Campaign for Schools

WEAP Model for the Catchment of Jeita Spring

BGR
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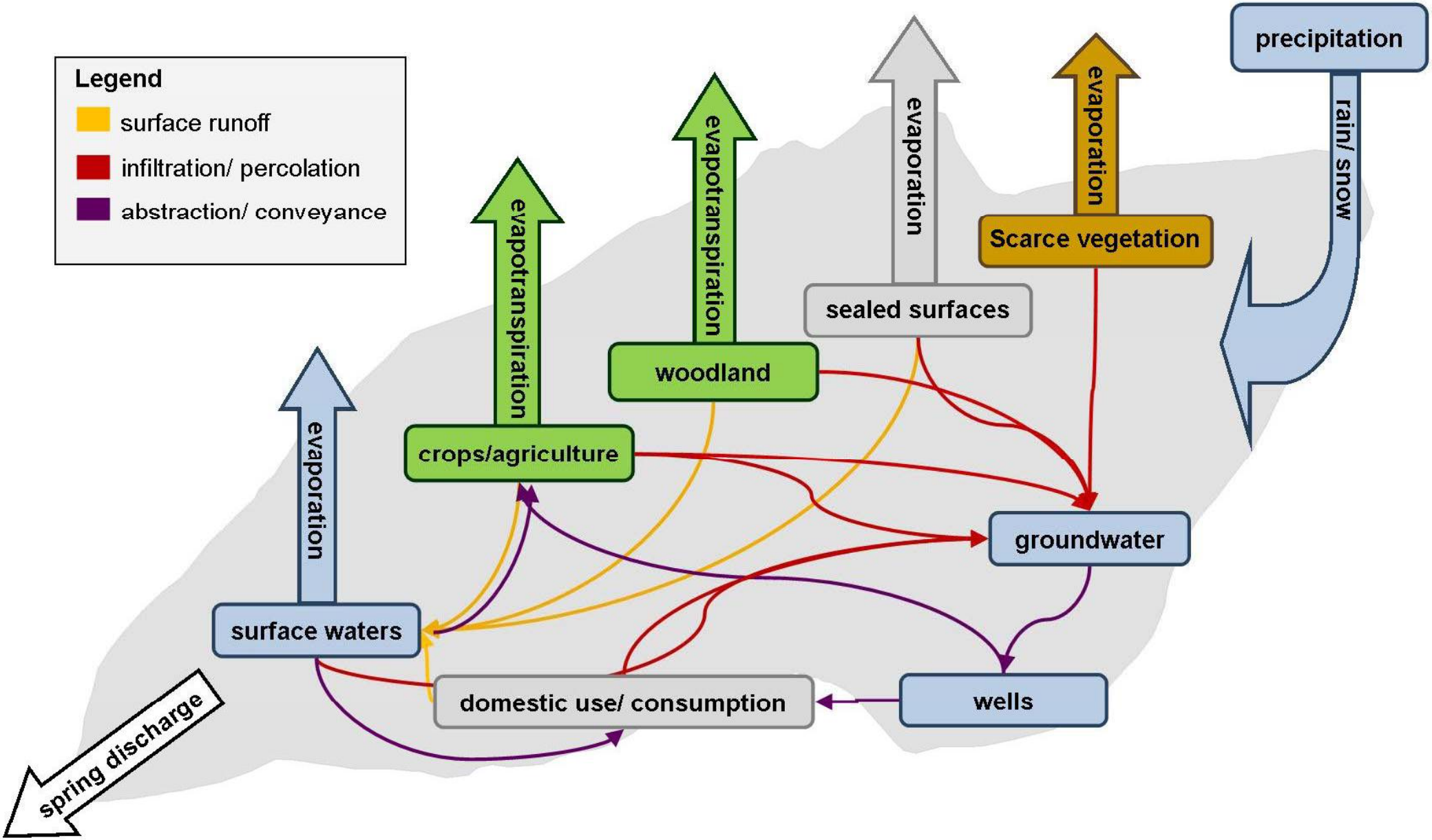
WEAP model I

- Water Evaluation and Planning
- Non-commercial software
- Developed by the Stockholm Environmental Institute
- Used within the MENA region
  - Jordan, Morocco, Tunisia, Palestine, Syria
- Conceptual in- & output model
- Modeling of hydrological budget
- Natural and anthropogenic supply and demand

WEAP model II



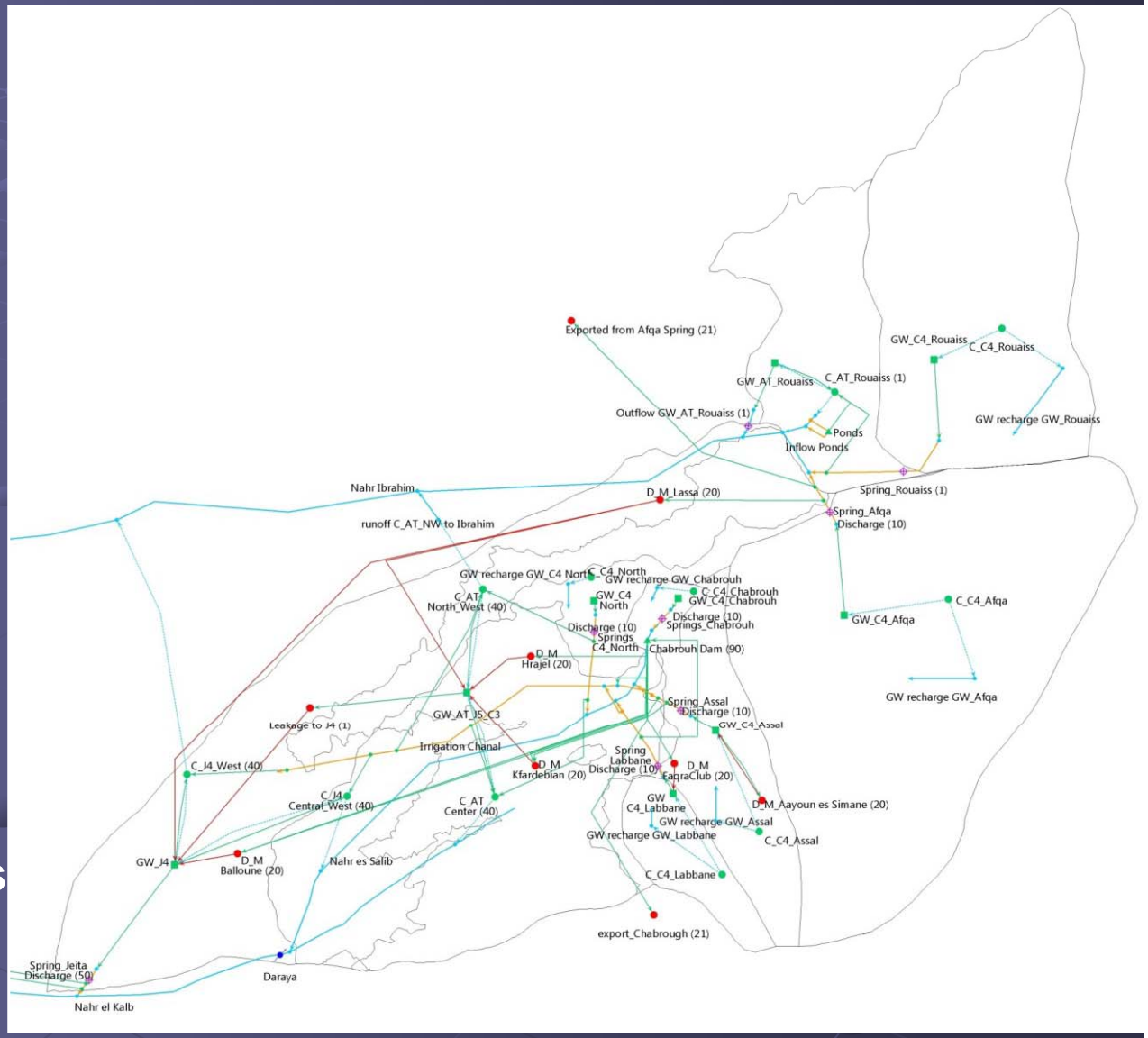
WEAP model III

- **Hydrologic equation:**
  - $P = R + ET + \Delta S$
- Precipitation (P) [MCM]:
  - $P_{availEtLc} = P_{HU} * area * P_{eff} * 10^{-5}$
- Runoff (R):
  - $Max (0, P_{availEtLc} - ET_{pot}) + (P_{LC} * (1-P_{eff})) + (1-IrrFrac) * Supp$
- Potential evapotranspiration (ET_{pot}) [MCM]:
  - $(ET_{pot}) = ET_{ref} + k_c + area$
- Actual evapotranspiration (ET_{act}):
  - $(ET_{act}) = Min (ET_{pot}, P_{availEtLc})$

- $P_{availEtLc}$: P available for evapotranspiration [MCM]
- P_{HU}: P on hydrological unit [MCM]
- P_{eff}: effective P [%]
- $]P_{LC}$: P on land cover unit [MCM[
- ET_{ref}: reference ET [mm]
- ET_{act}: actual ET [MCM]
- K_c: FAO crop coefficient
- Area: area pf land cover [ha]
- IrrFrac: Irrigation efficiency [%]
- Supp: supplied irrigation

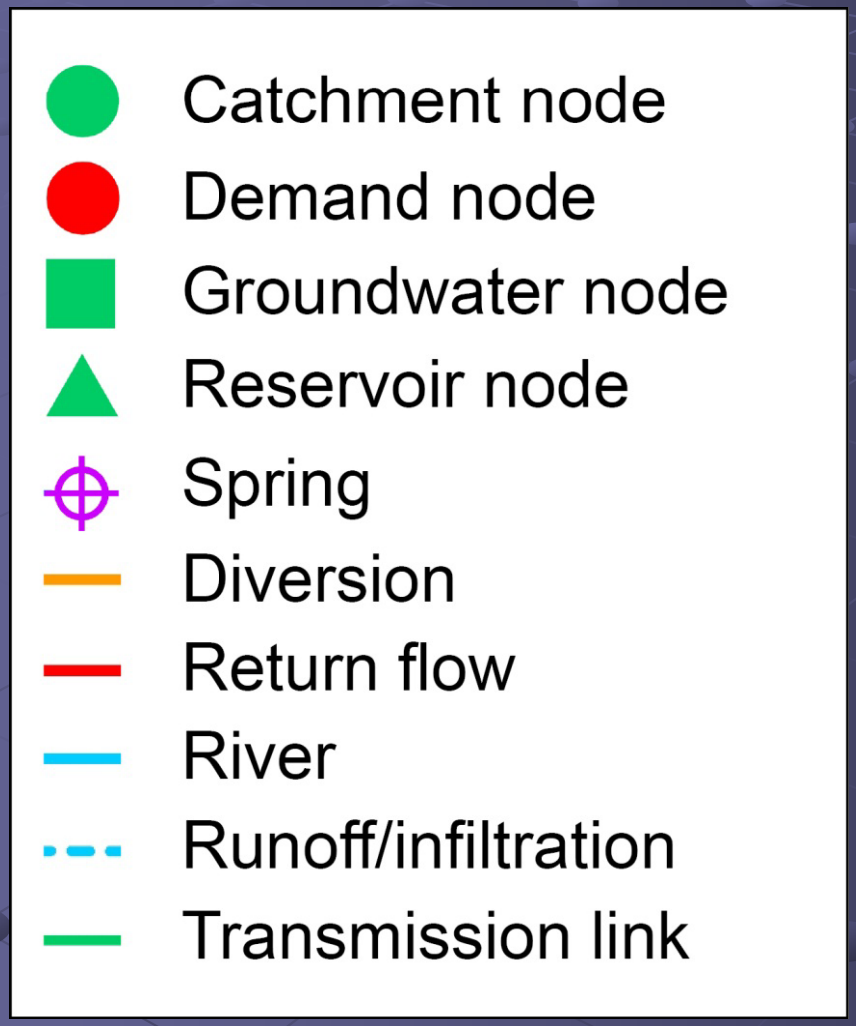
WEAP model IV

- **Input parameters:**
  - **Rainfall**
  - **ET**
  - **Landcover**
  - **Landuse**
  - **Domestic demand**
  - **GW abstraction**
  - **Irrigation canals**
  - **Irrigation efficiency**
  - **FAO crop coefficients**
  - **Chabrouh dam**
  - **…**

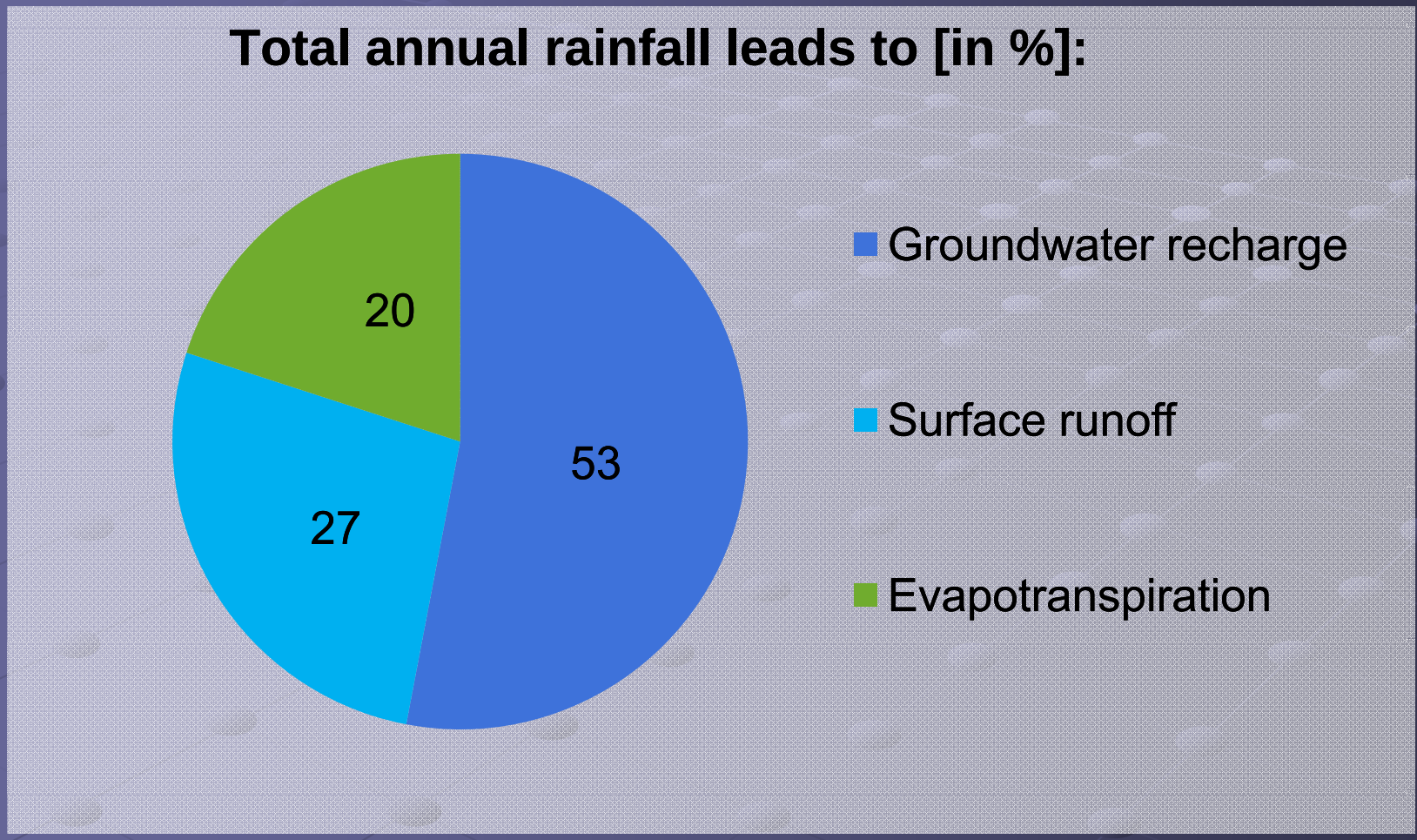


WEAP model V

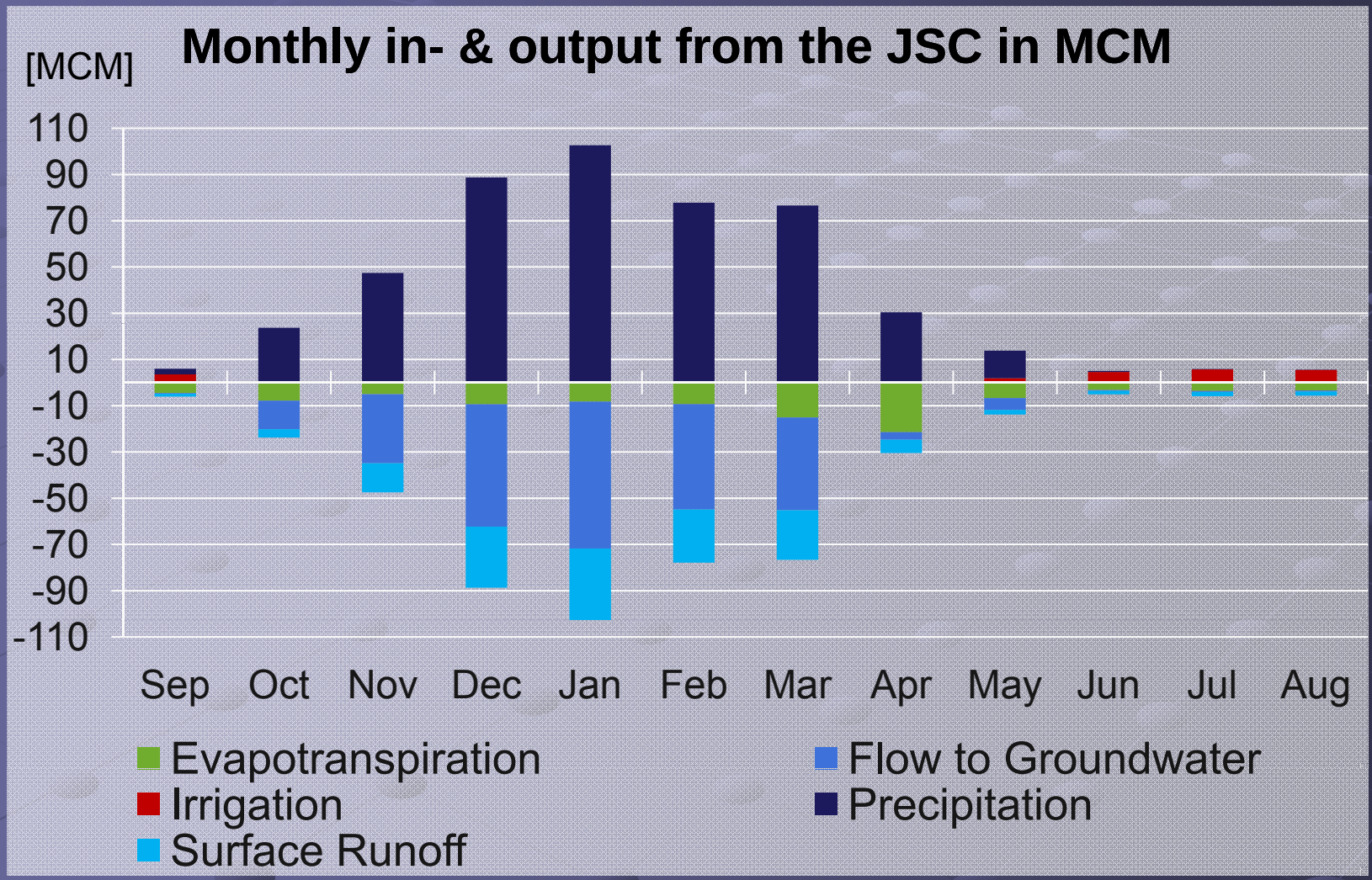
- **WEAP elements:**

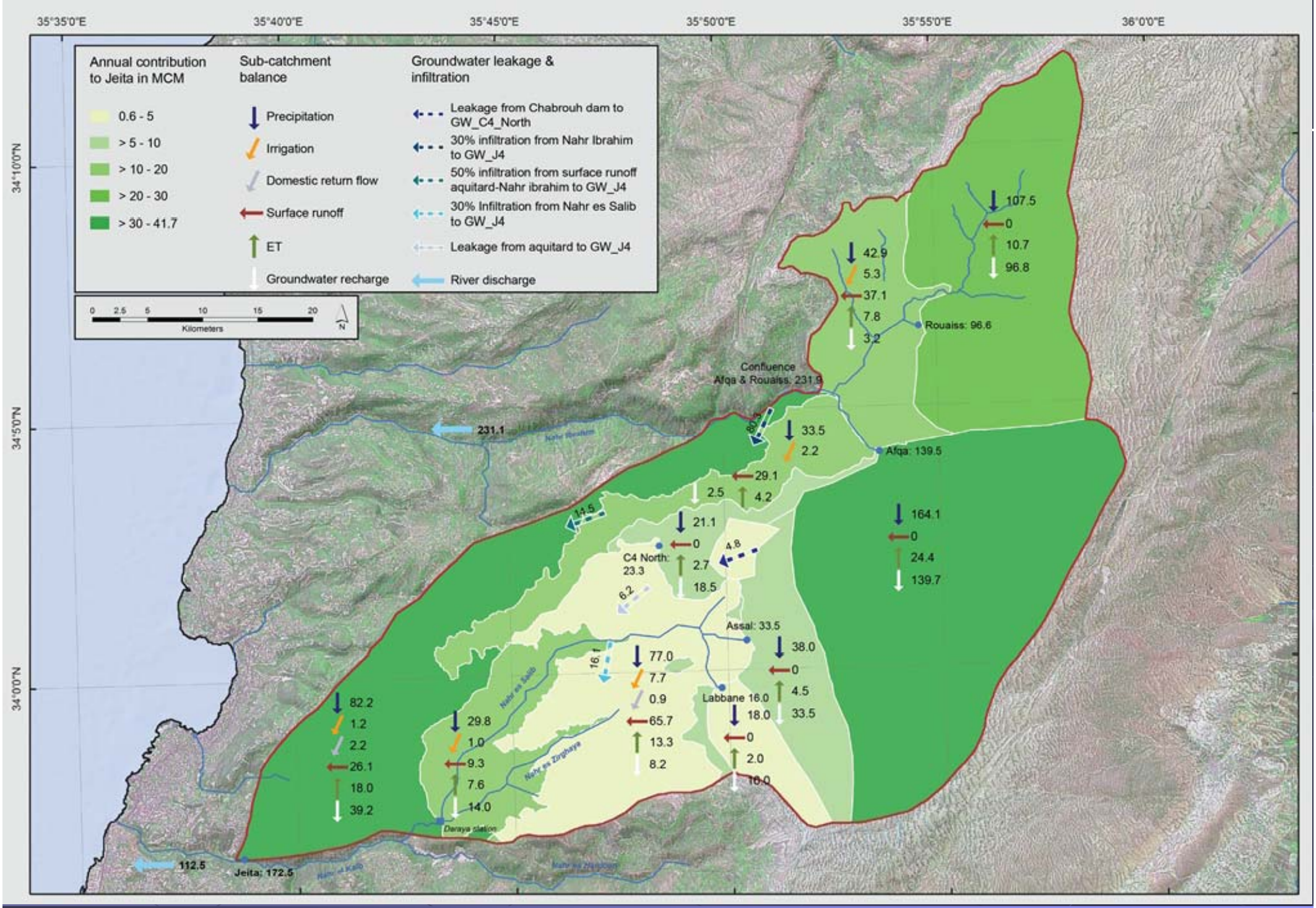


Results I


Total annual rainfall leads to [in %]:
20
53
27
Groundwater recharge
Surface runoff
Evapotranspiration

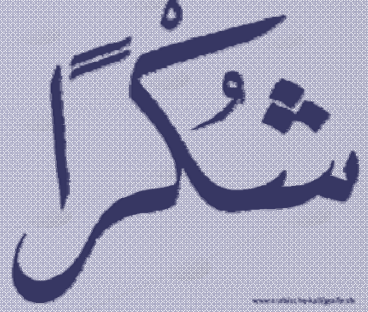
Results II


Monthly in- & output from the JSC in MCM
[MCM]
110
90
70
50
30
10
-10
-30
-50
-70
-90
-110
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Evapotranspiration
Irrigation
Surface Runoff
Flow to Groundwater
Precipitation


35°35'0"E
35°40'0"E
35°45'0"E
35°50'0"E
35°55'0"E
36°0'0"E
34°10'0"N
34°5'0"N
34°0'0"N
Annual contribution to Jeita in MCM
0.6 - 5
> 5 - 10
> 10 - 20
> 20 - 30
> 30 - 41.7
Sub-catchment balance
Precipitation
Irrigation
Domestic return flow
Surface runoff
ET
Groundwater recharge
Groundwater leakage & infiltration
Leakage from Chabrouh dam to GW_C4_North
30% infiltration from Nahr Ibrahim to GW_J4
50% infiltration from surface runoff aquitard-Nahr ibrahim to GW_J4
30% Infiltration from Nahr es Salib to GW_J4
Leakage from aquitard to GW_J4
River discharge
0 2.5 5 10 15 20
Kilometers
N
107.5
0
10.7
96.8
42.9
5.3
37.1
7.8
3.2
Rouaiss: 96.6
Confluence Afqa & Rouaiss: 231.9
231.1
Nahr Ibrahim
80.3
33.5
2.2
Afqa: 139.5
29.1
2.5
4.2
14.5
21.1
0
2.7
18.5
4.8
C4 North: 23.3
6.2
164.1
0
24.4
139.7
Assal: 33.5
16.1
77.0
7.7
0.9
65.7
13.3
8.2
38.0
0
4.5
33.5
Labbane 16.0
18.0
0
2.0
16.0
82.2
1.2
2.2
26.1
18.0
39.2
29.8
1.0
9.3
7.6
14.0
Nahr es Salib
Nahr es Zirghaya
Daraya station
112.5
Jeita: 172.5
Nahr al Kalb
Nahr es Zirghaya

Conclusion

- Establishing a water balance is a challenge:
  - Need to establish a data monitoring network
  - Central national database needed
  - Data sharing!
  - Need for expertise in hydrogeology
- Relatively high rates of surface runoff
  - Large potential of usable resources
- Construction of dams may be useful
- WEAP is a proper tool also for Lebanon



& Thank You!

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