



Catchment planning for water harvesting and soil water conservation: Jordan Badia an Example

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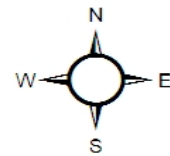
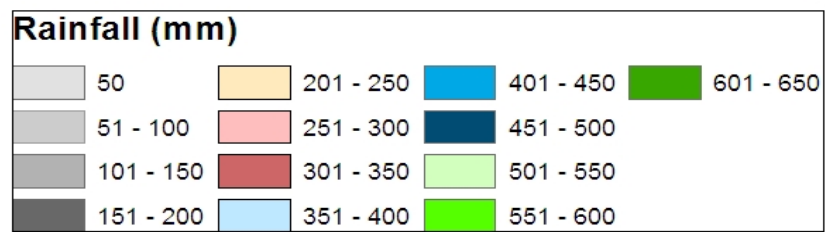
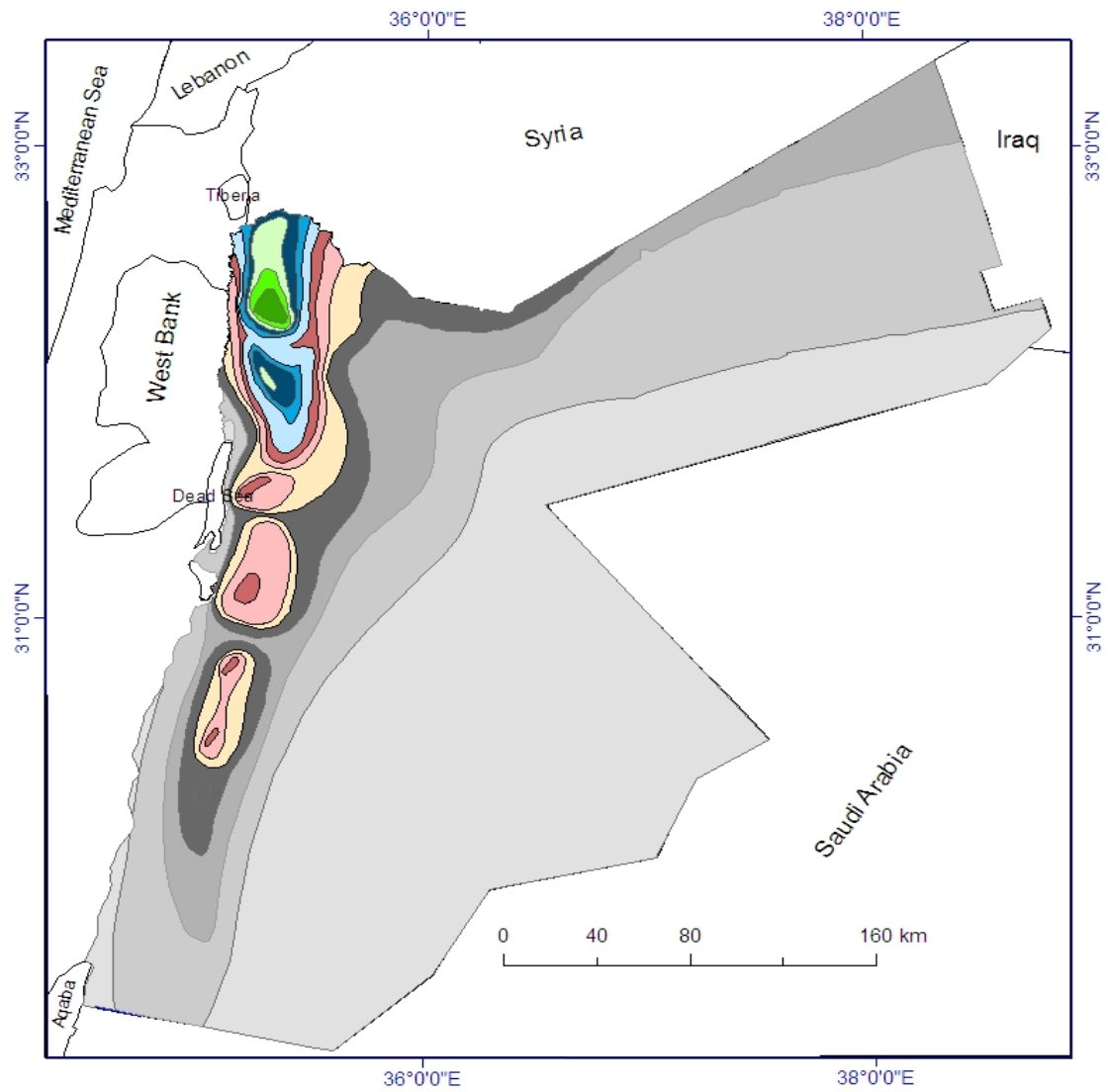
Department of Land, Water and Environment

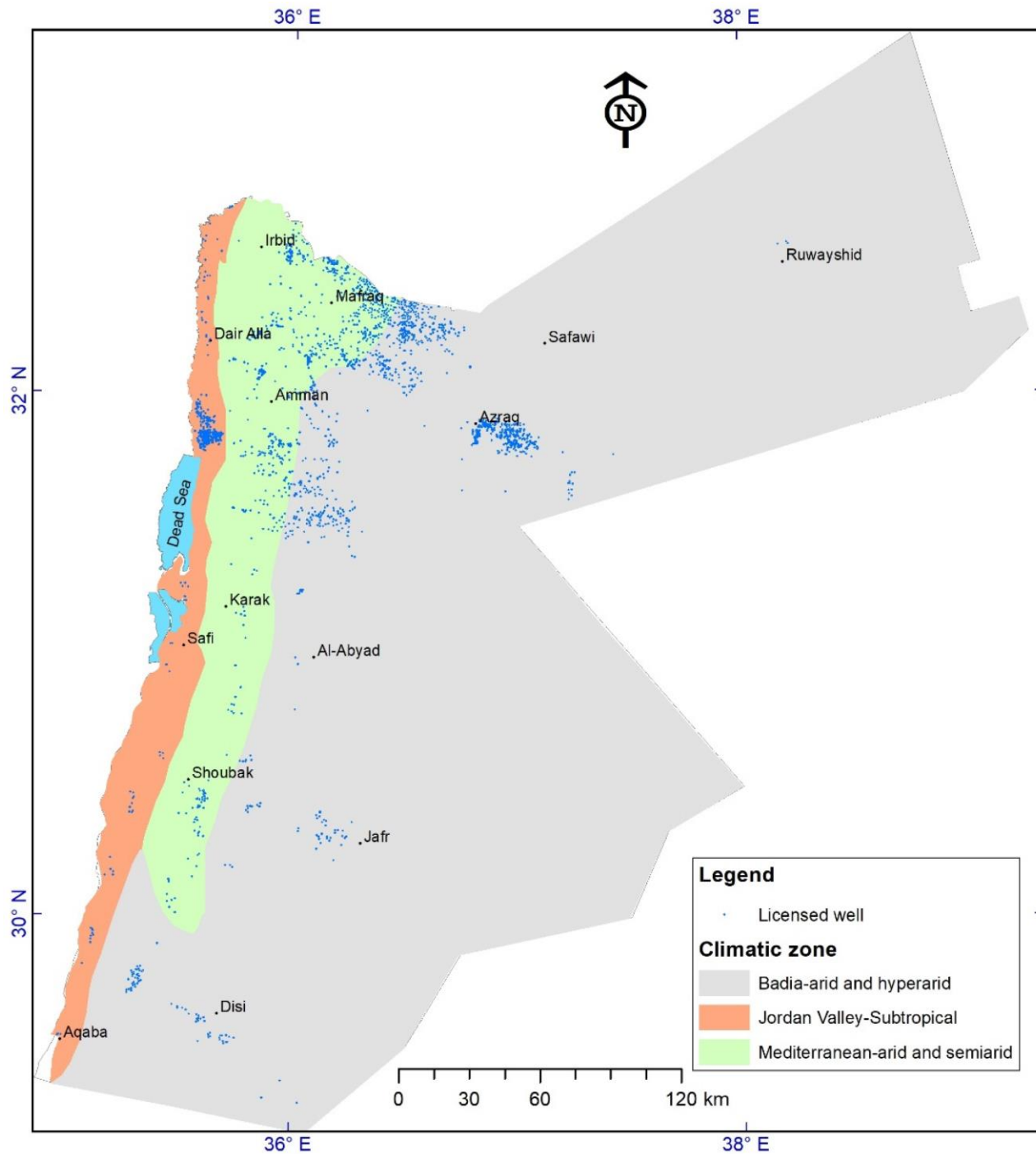
School of Agriculture

The University of Jordan

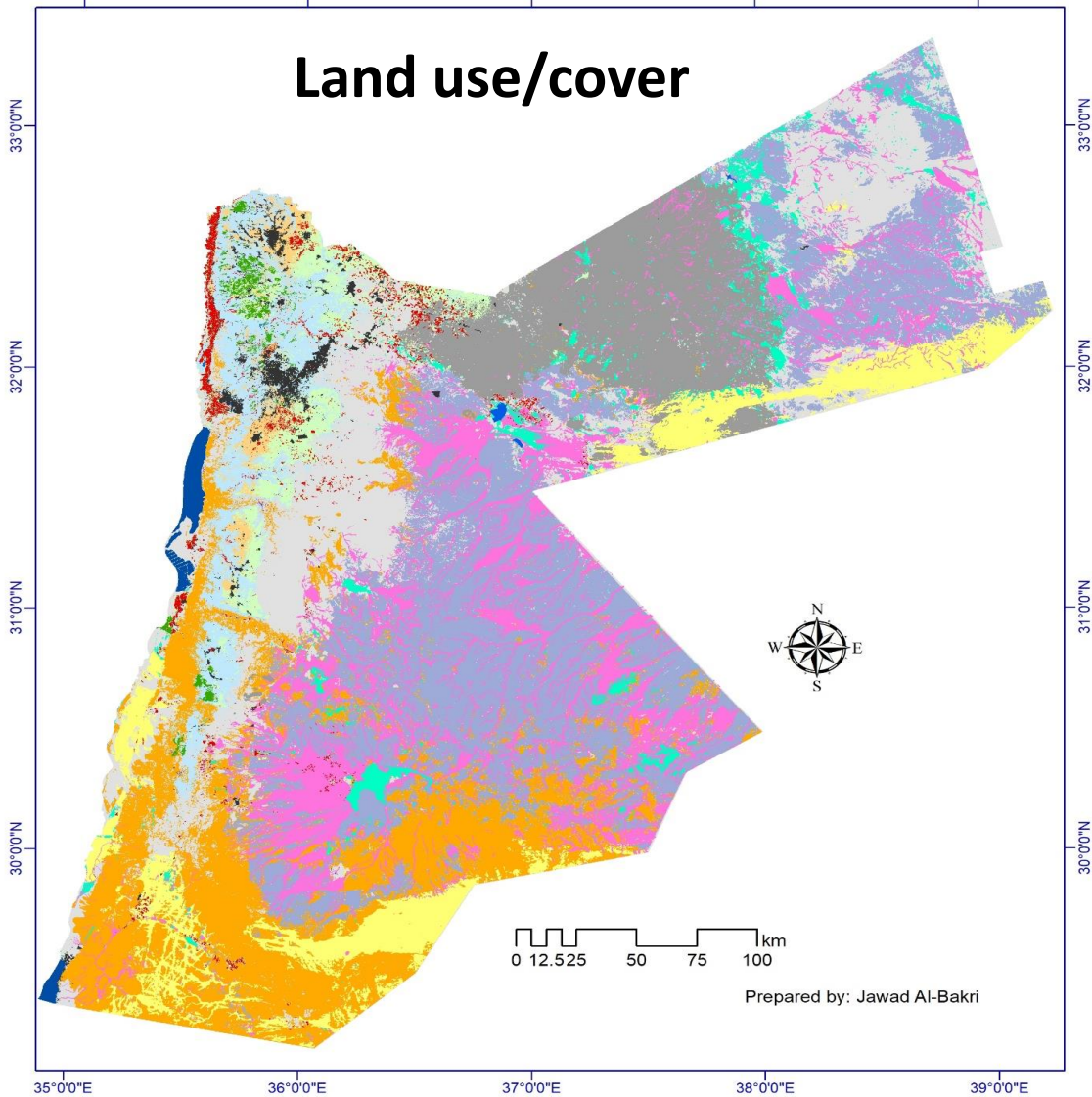
Contents

1. Land resources and biogeography of Jordan
2. Land degradation and need for soil and water conservation
3. Water harvesting and soil conservation in Badia
4. Outscaling of water harvesting
5. Conclusions





Land use/cover

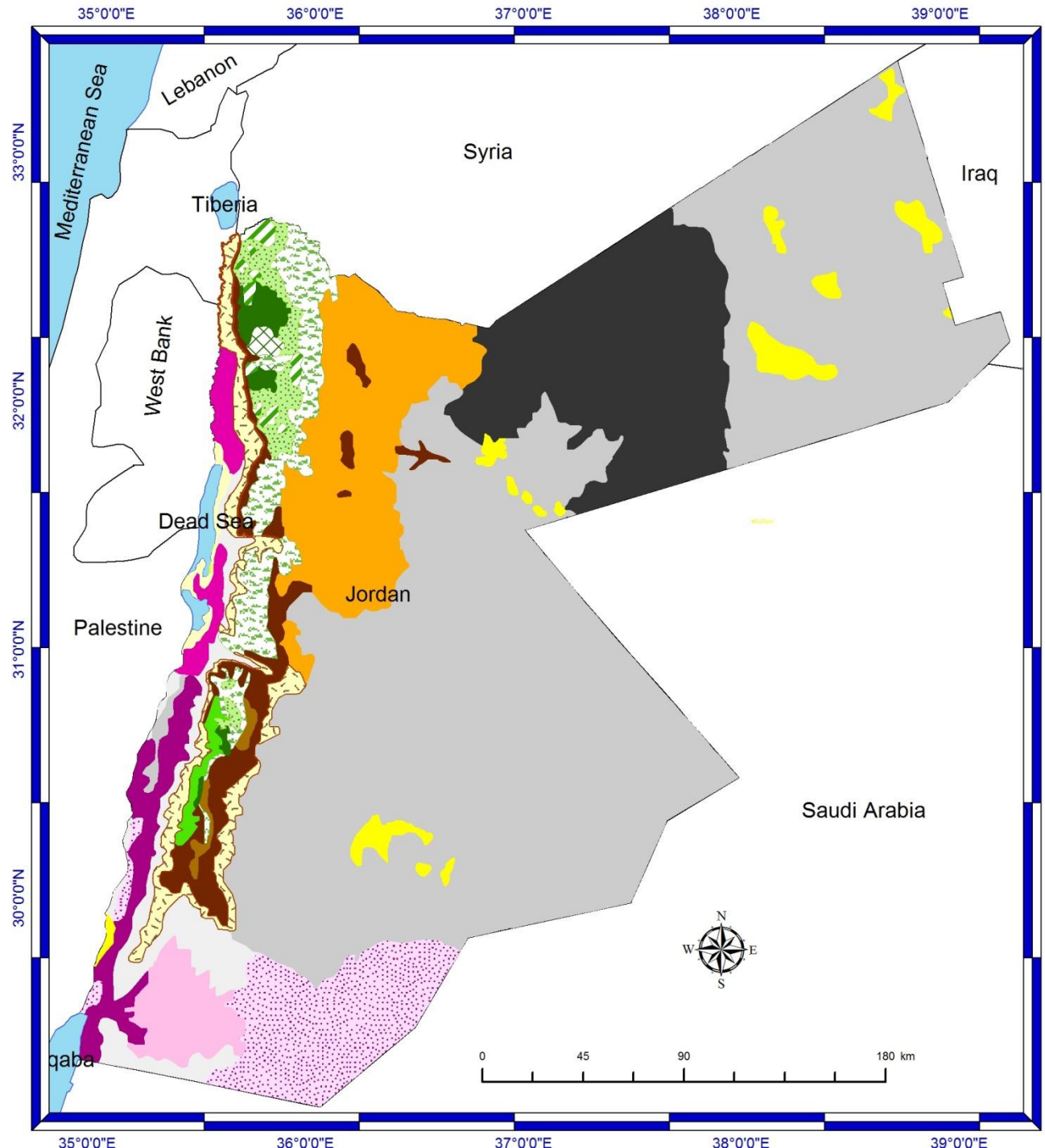


Land cover/use of 2017

 Urban, built-up areas	 Mud flat (Qa'a)	 Stone, basalt plain
 Cropland, fallow/rainfed	 Rangeland, Steppe	 Stone, chert plain
 Cropland, rainfed	 Sand plains	 Wadis of desert
 Cropland, irrigated	 Soil, bare and sparse veg.	 Water, dams and temporary
 Forest, open and closed cover	 Rock and mountains	 Water bodies, sea


Table 1: Analysis of land use/cover types in Jordan.

Land use/cover category (%)	Area (km ²)	%
Built-up, urban areas	899	1.00
Cropland, rainfed/fallow	2,487	2.78
Cropland, rainfed cereals and trees	1,090	1.22
Cropland, irrigated	958	1.07
Forest, open and closed cover	387	0.43
Mud flat (Qa'a)	2,305	2.57
Rangeland, Steppe	4,215	4.71
Sand plains	6,303	7.04
Soil, bare and sparse veg.	14,868	16.60
Rock and mountains	14,029	15.67
Stone, basalt plain	9,027	10.08
Stone, chert plain	20,243	22.61
Wadis of desert	12,144	13.56
Water bodies, dams	59	0.07
Water, sea	530	0.59
Total	89,544	100



Vegetation Type




Mediterranean

-  Evergreen oak forests
-  Wild Phoenician Juniper forests
-  Deciduous oak forests
-  Wild Aleppo pine forests
-  Mediterranean non forest vegetation-Batha
-  Batha-Steppe

Irano-Turanian

-  Artemisia herba-alba steppe
-  Noaea mucronata brush
-  Grassland steppe
-  Mixed steppe and Saharo-Arabian vegetation



Saharo-Arabian

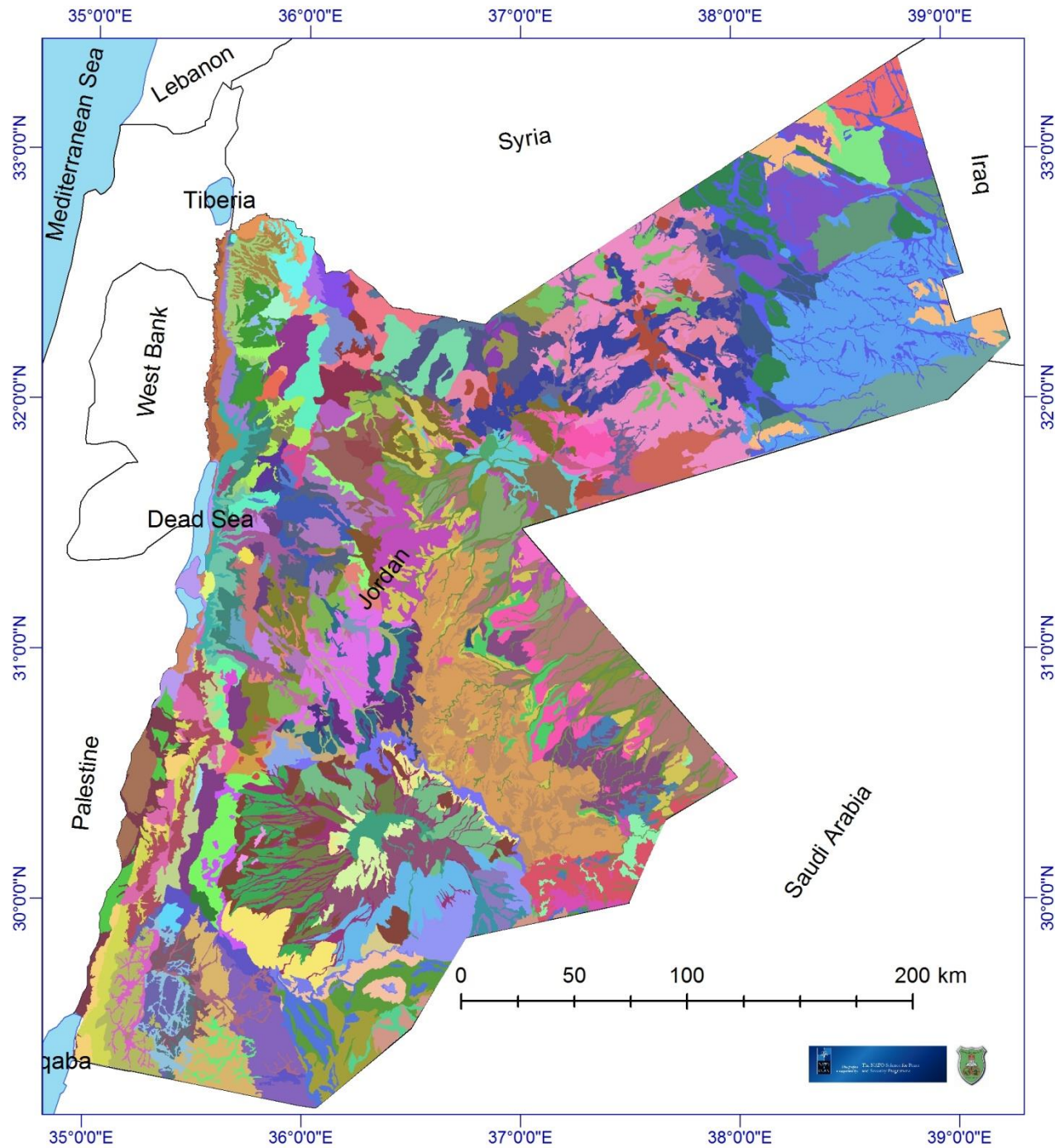
-  Scrub on the basalt
-  Chert hammada Vegetation
-  Sandy Hammada

Sudanian Penetration

-  Acacia woodlands
-  Zizphus Spina-Christi and Balanites aegyptiaca formations
-  Weathered sandstone and granite scrub
-  Sand dunes vegetation

Salt and mud flats

-  Salt and mud flats
-  Water and saline vegetation of the marshlands



- Legend**
- | | | |
|-------|-------|--------------------|
| QAS13 | HAF6 | <all other values> |
| QUT14 | HAL11 | LEGEND |
| RAB9 | HAR14 | ABU17 |
| RAF12 | HAS14 | ABY11 |
| RAJ13 | HAT11 | ADR11 |
| RAM6 | HAY3 | AHA13 |
| RAQ6 | HEI14 | AJL18 |
| RAT7 | HIM4 | ALB13 |
| RIJ14 | HIR6 | ALI8 |
| RIS2 | HIS6 | ALL4 |
| RTE7 | HRA7 | AMU12 |
| RUW17 | HUD13 | ANJ8 |
| SAB15 | HUM10 | AQB6 |
| SAF2 | HUM9 | ARA2 |
| SAH6 | HUQ17 | ARJ11 |
| SAK18 | IBB18 | ASM13 |
| SAY11 | IRB8 | ATT13 |
| SHA16 | IRI8 | AWI16 |
| SHE12 | ISH6 | AYD8 |
| SHU12 | ISS13 | AZR13 |
| SIB17 | JAB7 | BAK10 |
| SIS11 | JAD10 | BAN8 |
| SNW13 | JAD9 | BAQ8 |
| SUF8 | JAF12 | BAS10 |
| TAD2 | JAJ12 | BAY11 |
| TAF10 | JAL8 | BID12 |
| TAR11 | JAN12 | BIR8 |
| TAW3 | JAW16 | BIS15 |
| TEL12 | JER8 | BRA11 |
| TFI16 | JID13 | BST17 |
| THA15 | JUL13 | BUQ8 |
| TIR3 | JUR12 | BUR8 |
| TUA17 | KAT1 | DAB11 |
| TUB7 | KHH12 | DAJ11 |
| UBI16 | KSH6 | DAR4 |
| UFA13 | KUF8 | DAT4 |
| UKH13 | LAN16 | DEI11 |
| URF2 | LIM13 | DHI2 |
| URF5 | LIS2 | DHU15 |
| WAH13 | MAD8 | DIS6 |
| WAN3 | MAG14 | DISTURBED LAND |
| WAY15 | MIN12 | DUG13 |
| WER9 | MIR17 | DUR13 |
| YAB11 | MNK17 | FAR15 |
| YAD8 | MUD7 | FIH12 |
| YAR8 | MUG9 | FUJ11 |
| YAT12 | MUJ4 | FUL13 |
| YIL12 | MUS12 | FUR17 |
| YIR13 | NAD14 | FUW10 |
| YUT5 | NAB16 | GAB11 |
| ZAR8 | NAY13 | GAR2 |
| ZAY4 | NIS11 | GHU7 |
| ZIL11 | NUH12 | GOR1 |
| ZOR1 | NUJ17 | HAB8 |
| ZUM15 | NUK16 | HAF14 |
| | QAL14 | HAF5 |

Soil properties-Muwaqar

1-Low organic carbon content.

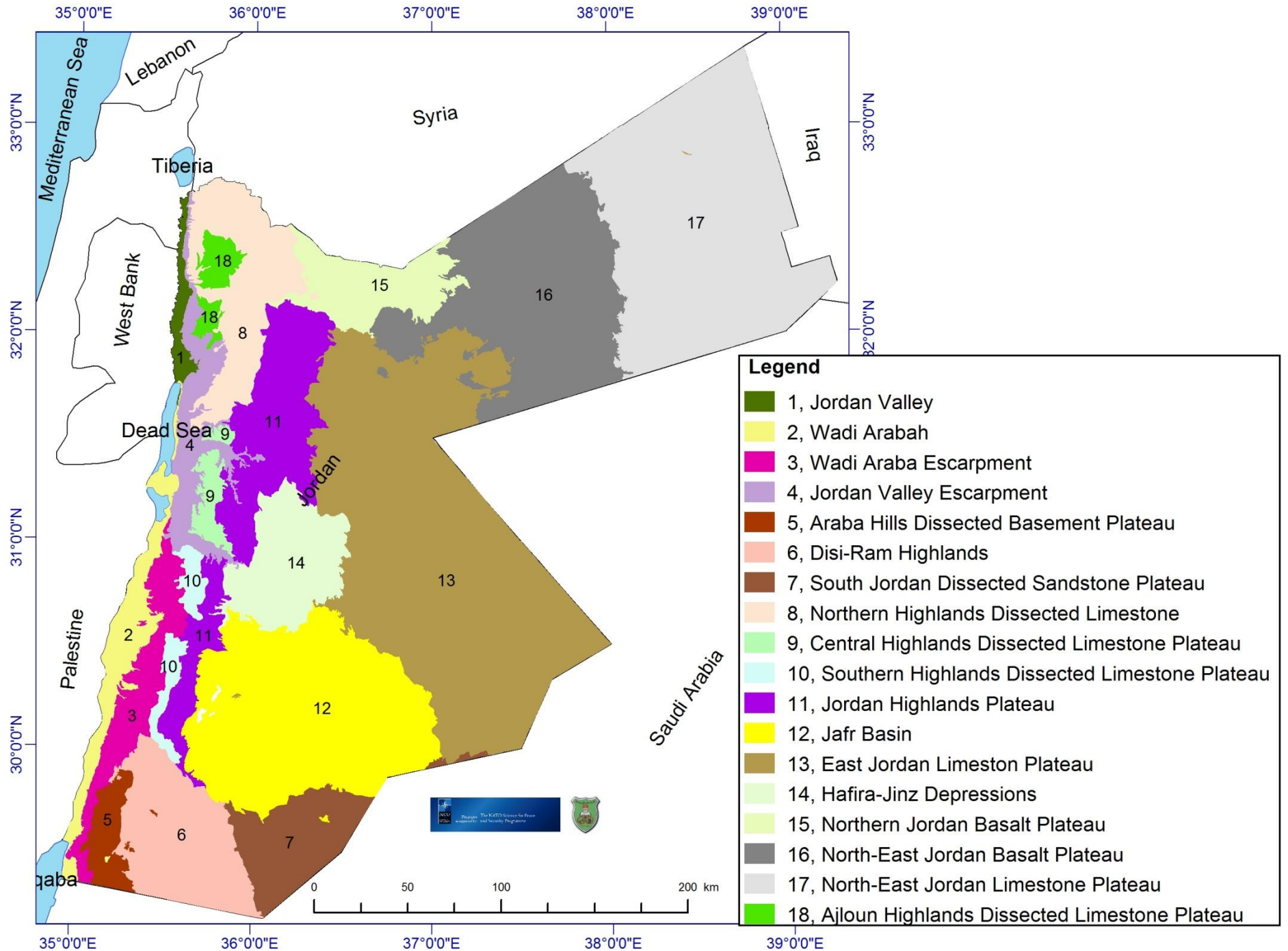
2-Poor soil aggregation.

3-High silt content.

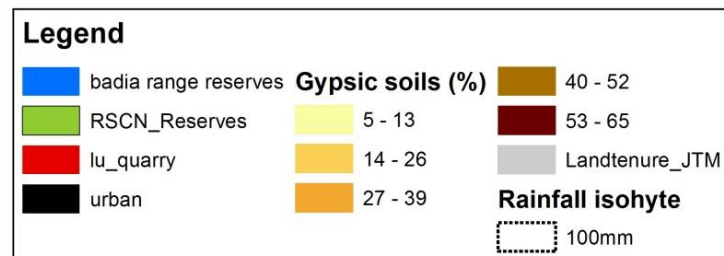
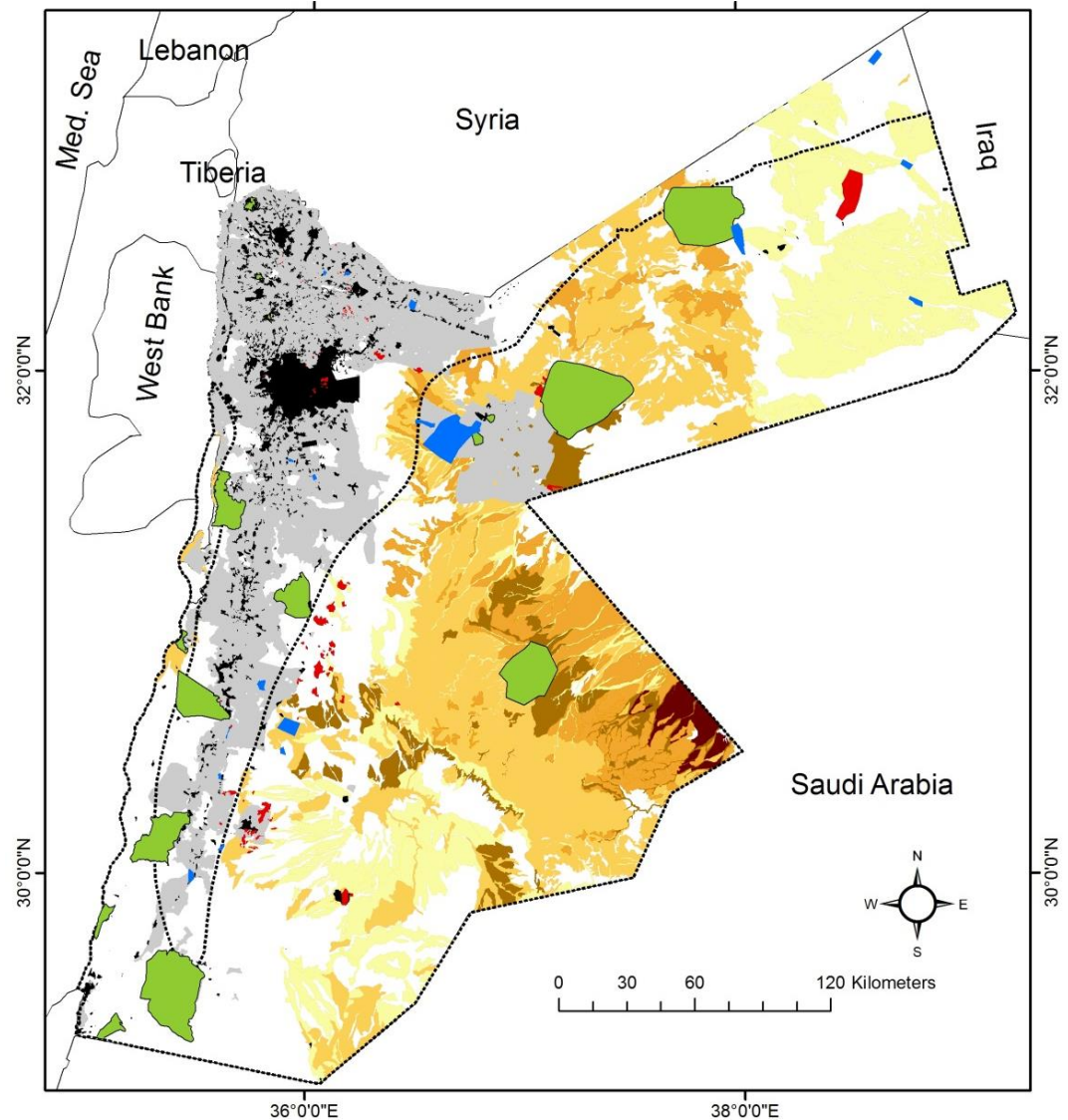
4-Strong surface crust with low infiltration rate.

5-Low clay content.

6-Low-medium water holding capacity.



- Most of the lands with rainfall > 100 mm are privately owned.
- Remaining lands represent fragile ecosystems with limitations of poor soil quality, lack of infrastructure and harsh environmental conditions



2. Land degradation in Jordan

- Types: erosion by water and wind, salinization and alkalinization from irrigation.
- Natural Causes: Continuous and frequent droughts
- Human induced causes:
 - Unsupervised land management (early and heavy grazing, wood cutting, plowing of fragile soils..etc.)
 - Social: Land fragmentation and land tenure problems
 - Political instability in the region
 - Institutional: Financial and legal



2. Land degradation in Jordan

- Theoretically, more than 90% of the country's land is threatened.
- Permanent damage to some areas is irreversible.
- Quantitative data on status and rate is still missing.
- Social dimension of the problem is serious (high link to poverty and poor infrastructure).
- No allocated governmental budget, only initiatives and project-based rehabilitation.

3. Water harvesting and soil conservation in Badia

- Project-based initiatives showed good potential for rangeland recovery with WH interventions.
- Examples on locations with successful recovery were reported by Badia Program of the HCST and Research projects for UOJ and NARC.



After protection

Restoration with WH Contour bunds



Grazing and land degradation



Restoration

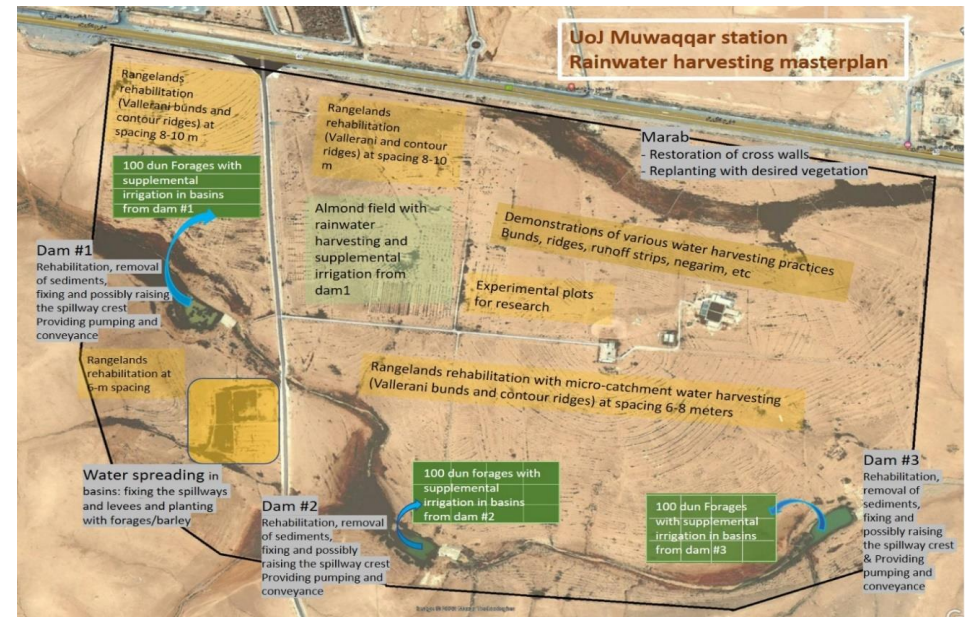
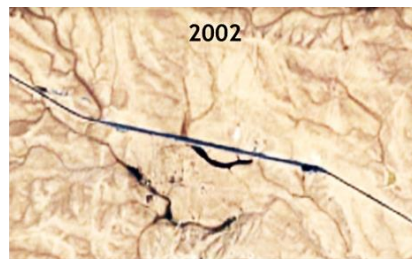
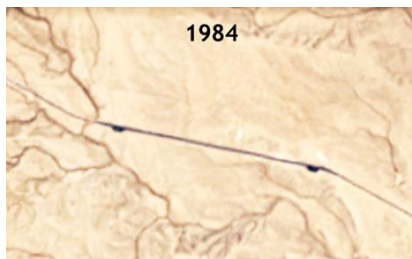


Restoration with WH Contour bunds



Muwaqqar Research Station as an example

- 400 ha east of Amman at the western side of Azraq basin
- Activities started in early 1980
- WH activities and research experiments on soil and water
- Available data include detailed soil and vegetation sampling.



More details on Monday trip (Prof. Abdallat)

Muwaqqar Research Station as an example

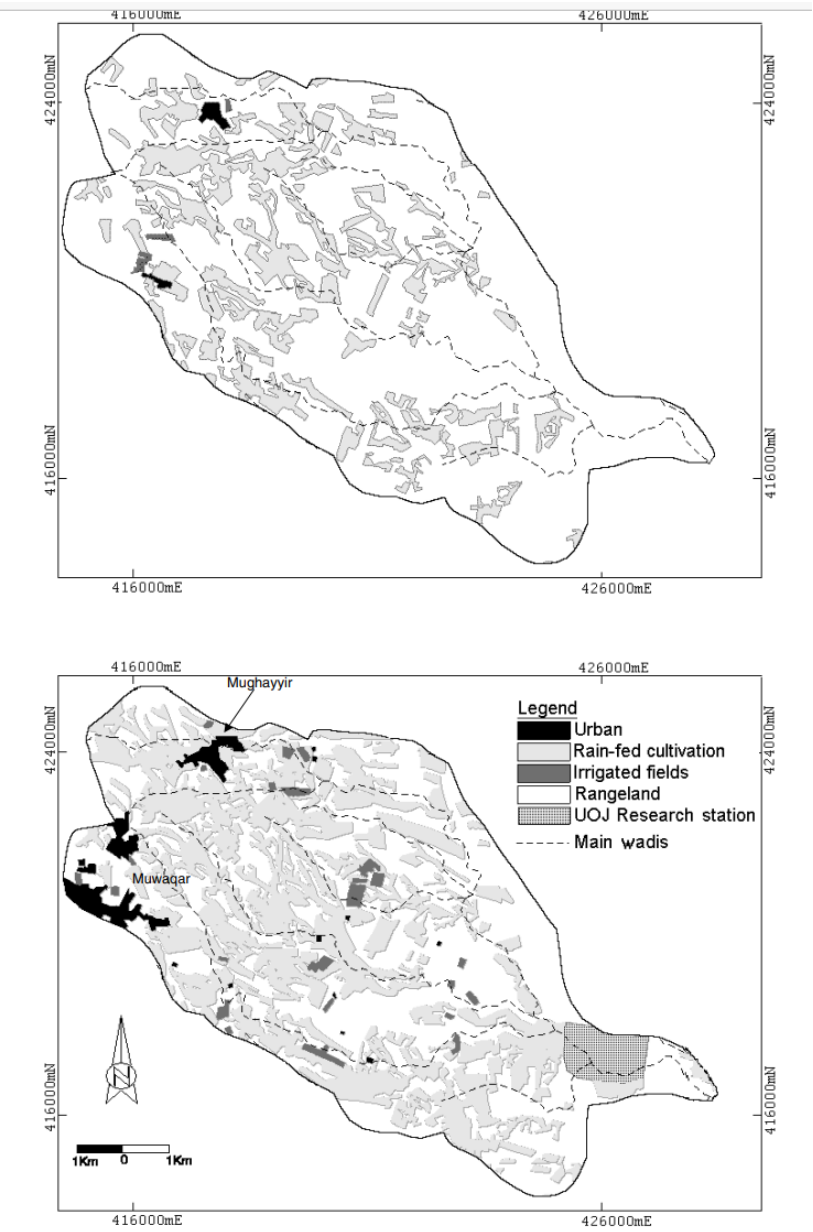
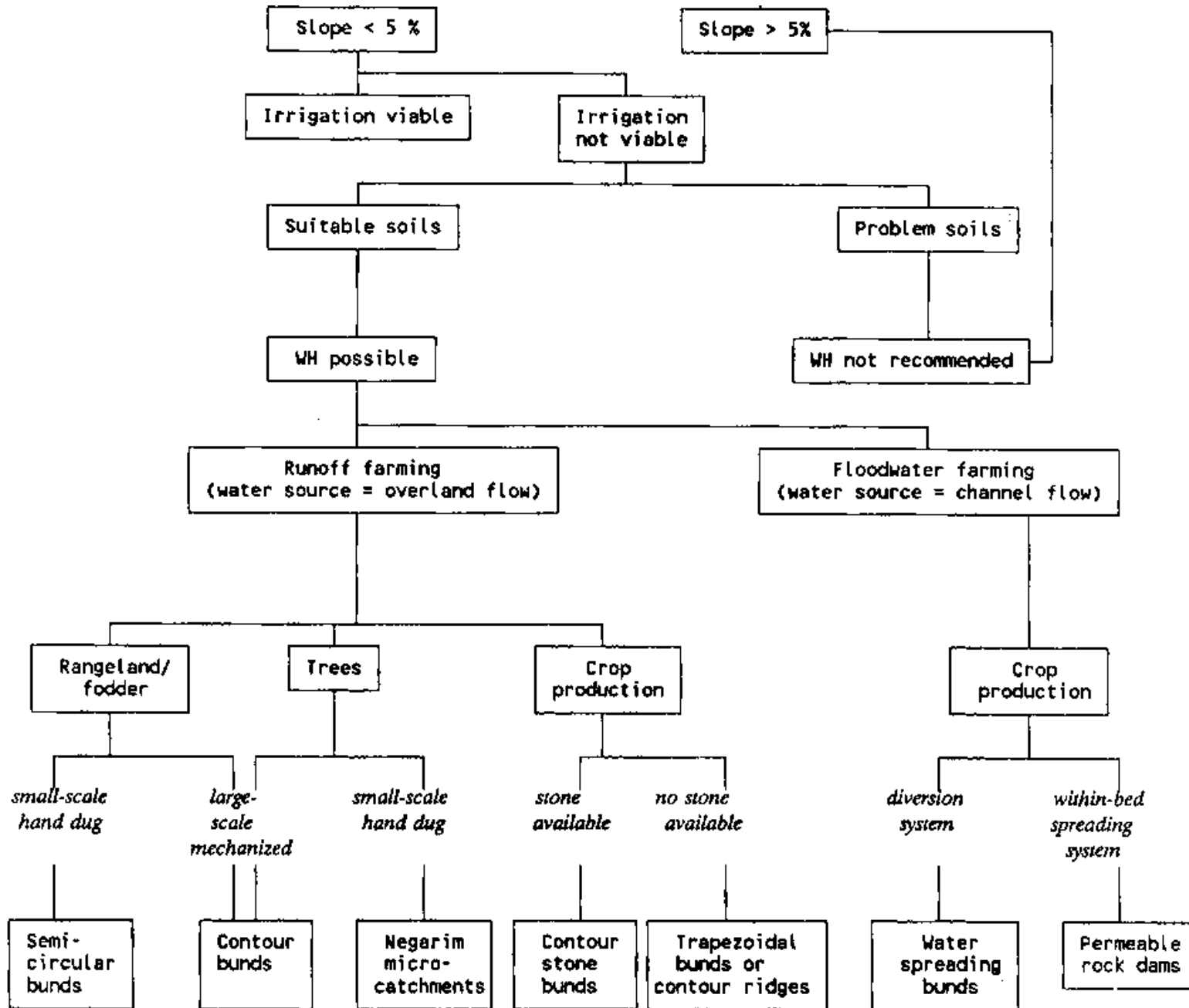
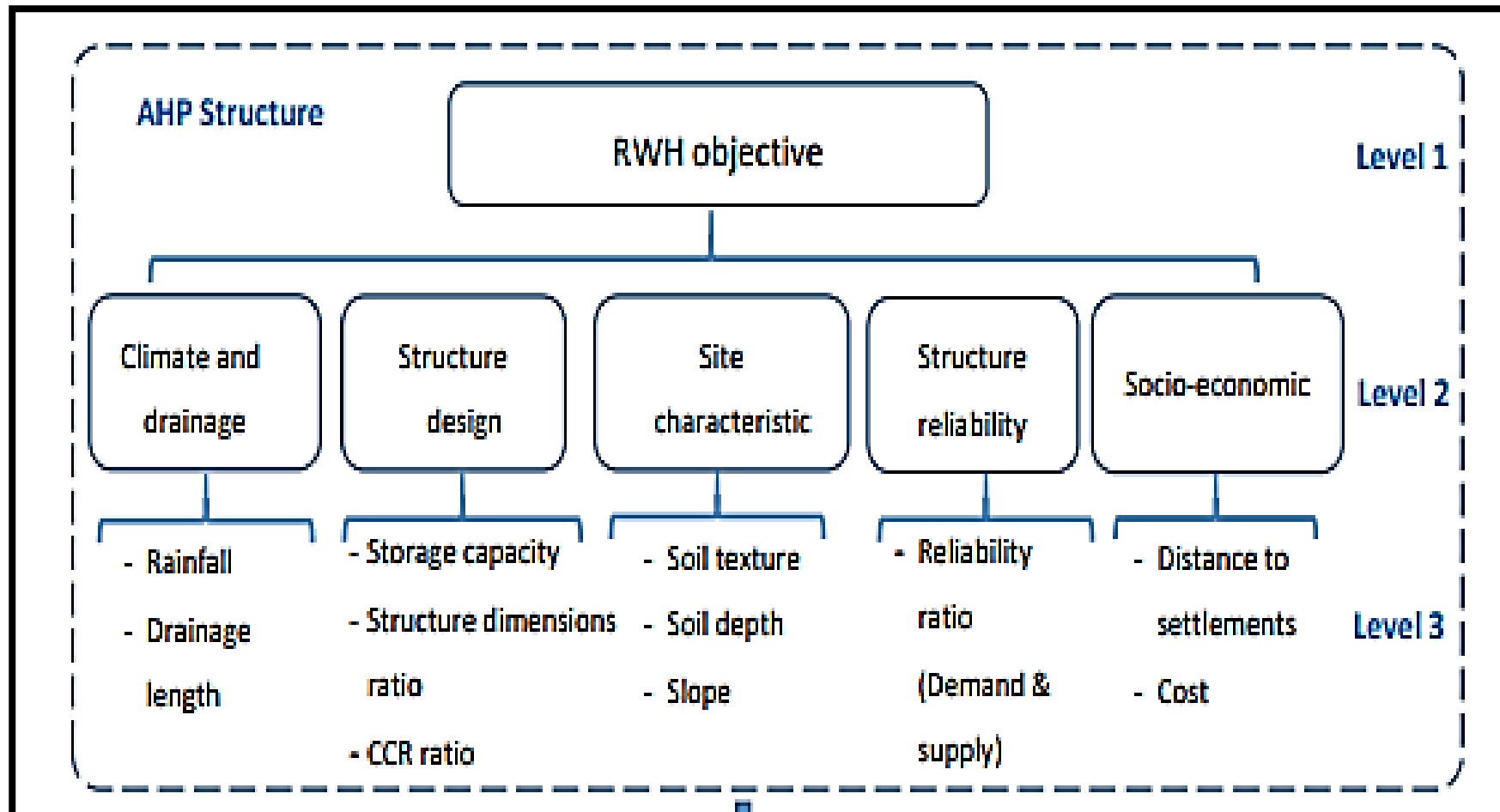


Figure 4 Land use maps derived from aerial photography of Muwaqqar: 1978 and 1992

4. Outscaling of water harvesting



4. Outscaling of water harvesting: all factors



1. Socioeconomic factors can be causes of success and failure.
2. Involvement of society is important
3. Indigenous knowledge and level of skills (training).
4. Environmental and social impacts: Is the structure prohibiting their movement or lifestyle?

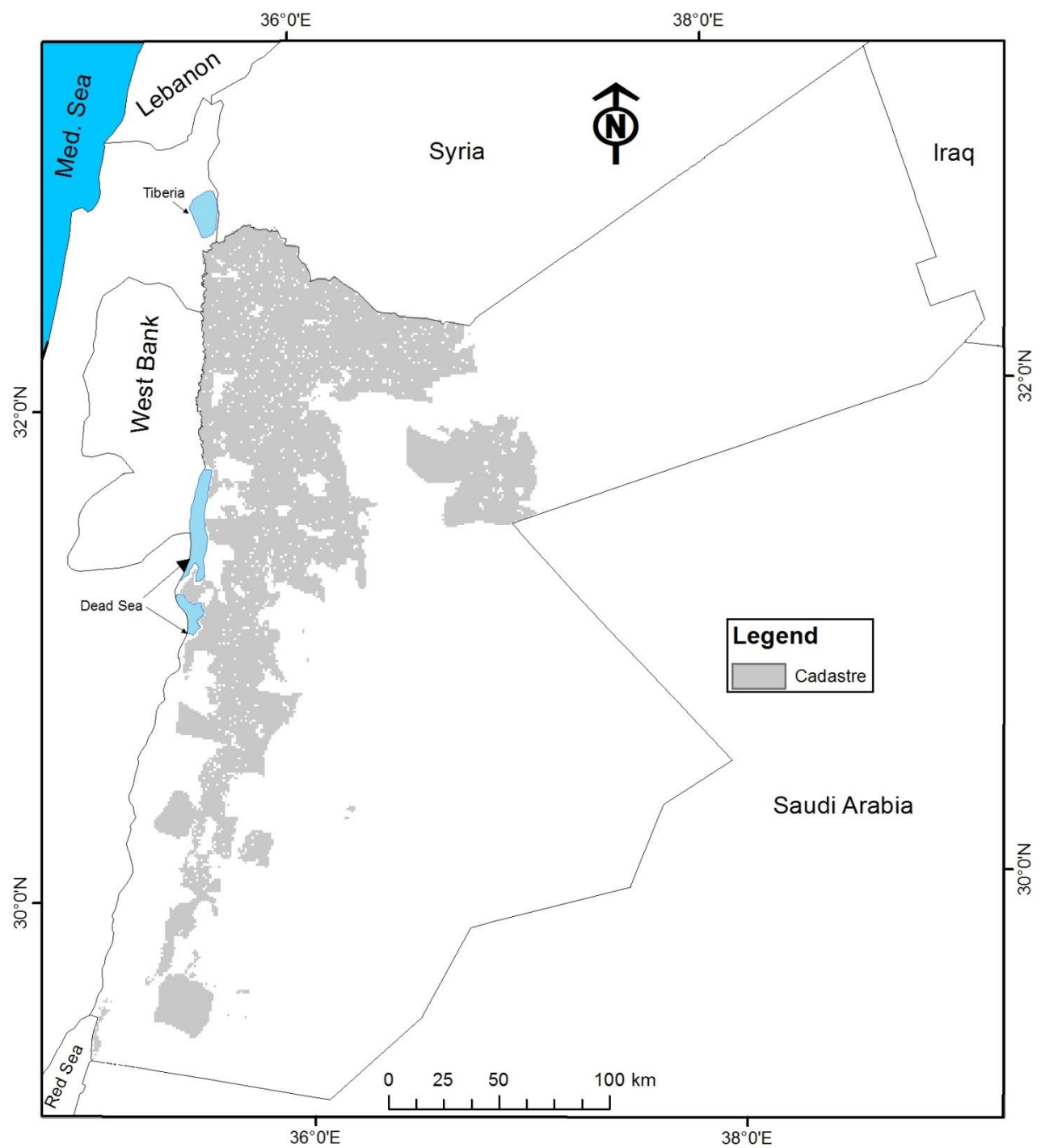
4. Outscaling of water harvesting: GIS based approach

- Use of Digital Elevation Model (DEM) and GIS.
- Refining selection based on intersected maps (rainfall, land tenure, land use/cover..etc.).
- Socioeconomic survey and stakeholders' consultation
- Finalized plan
- Implementation
- Monitoring and Assessment (M&A)

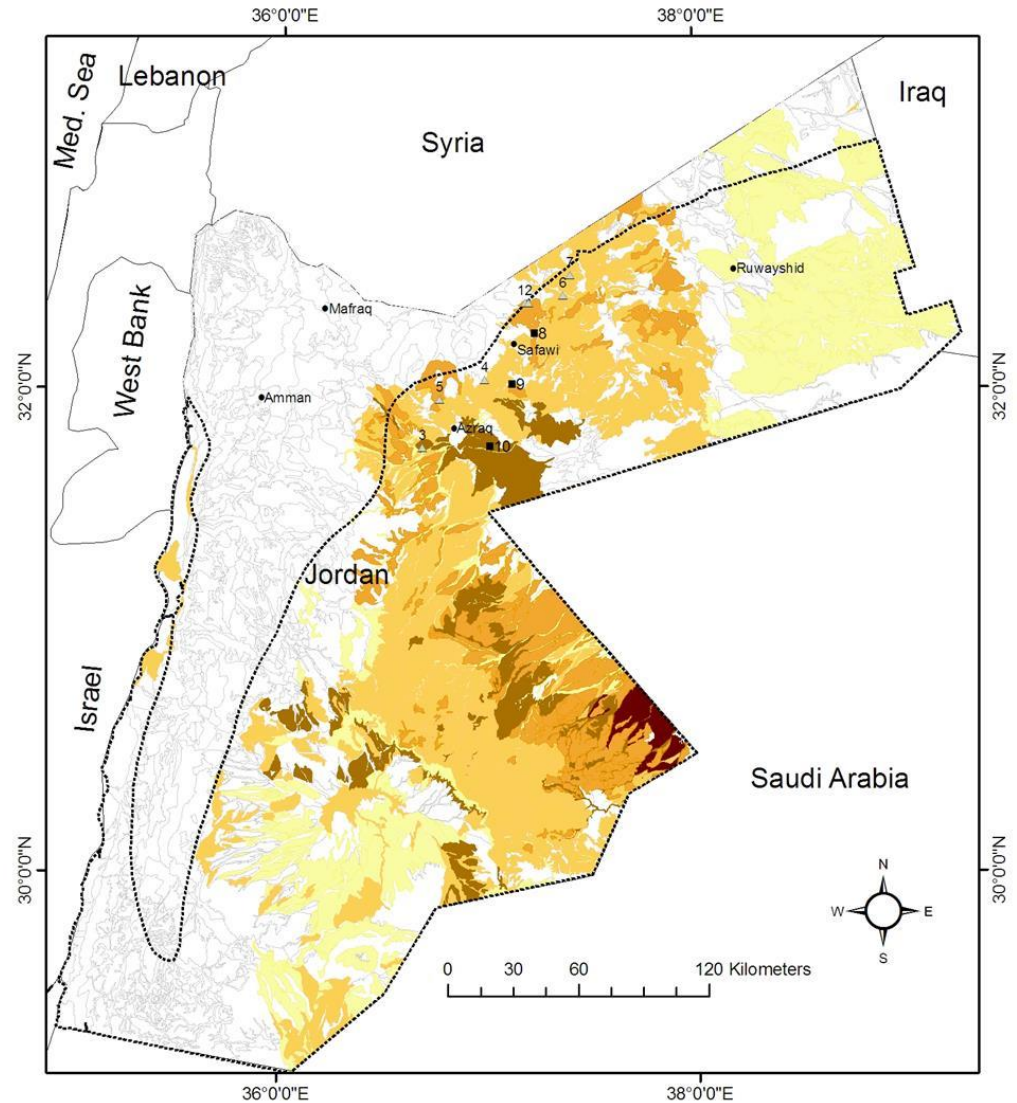
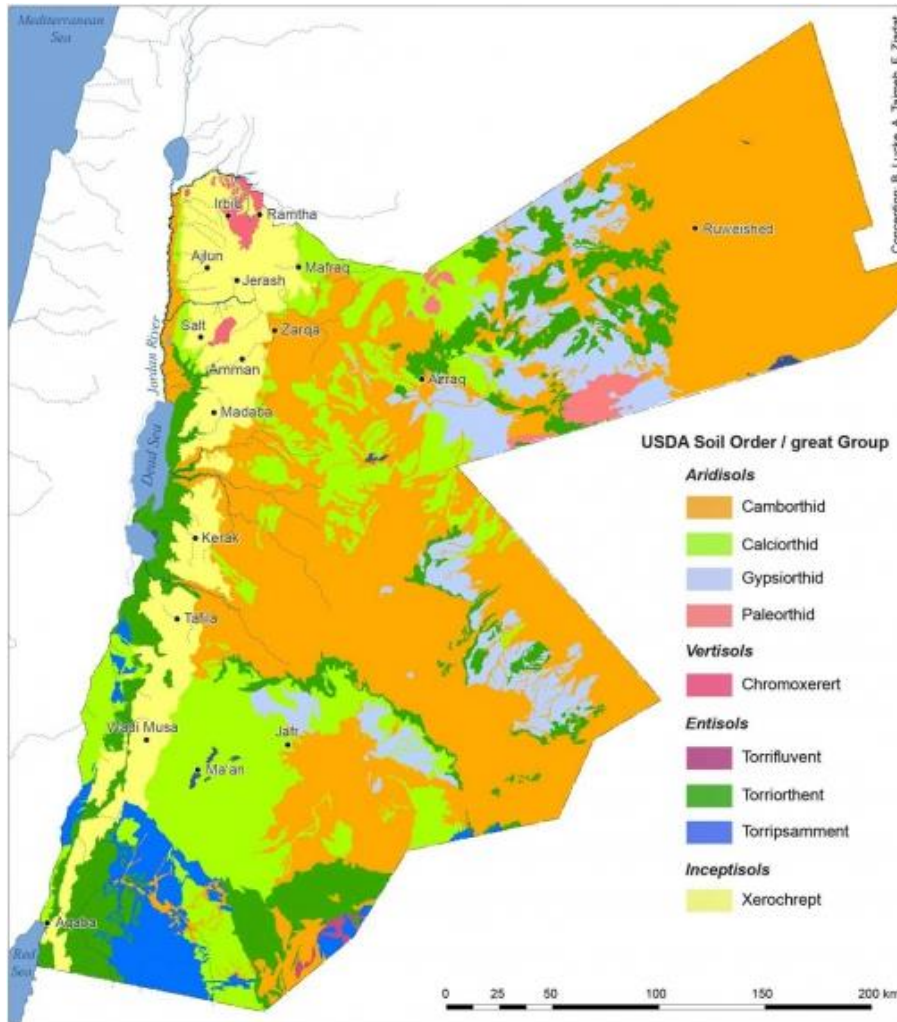
Parameter	Criteria for selection
Rainfall	Inclusion of rangeland areas with mean annual of ≤ 200 mm
Land tenure	<ul style="list-style-type: none"> - Treasury land is preferred over privately owned land. - Landholding size of 1.0 ha or more for privately owned lands.
Soil Limitations	Exclusion of areas with high salt contents, sand dunes, mudflats (depressions), high content of gypsum enriched soils.
Land Use/cover	Exclusion of Urbanization, irrigated areas, areas with industrial activities (quarries, excavation, oil and gas).
Accessibility and Infrastructure	Roads and accessibility, watering points.
Topography and vegetation	<ul style="list-style-type: none"> - Slope range is 1-6%, i.e. suitable for micro water harvesting needed for restoration. - Vegetation type is including either shrub or grass rangelands or both based on the NDVI class.

3. Maps for characterization and selection

Land tenure



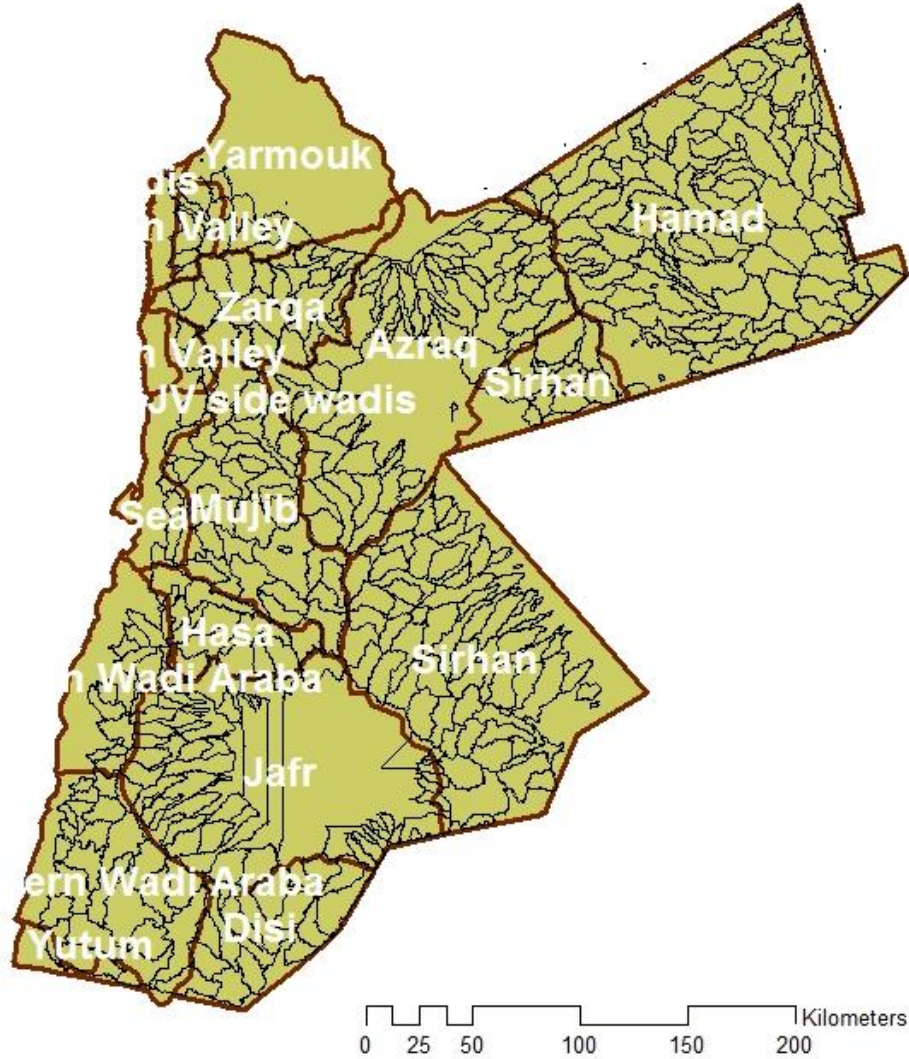
3. Maps for characterization and selection: Soil



3. Maps for characterization and selection: Others

- Master land use plans
- Infrastructure (roads, watering points)
- Vegetation conditions (types and remotely sensed indices)

Main Characteristics of Watersheds



Appending Attributes

The screenshot displays a GIS application window with a topographic map in the background. On the left, a 'New Data Frame 2' panel lists various data sources, including 'Zarqa_Streams' and 'Zarqa_shds_GCS'. The 'Zarqa_shds_GCS' layer is selected, and its attributes are shown in a table on the right. The table has columns for FID, Shape, ID, Area_sqkm, and Name. Row 8 is highlighted, showing a polygon with ID 174 and an area of 128 sqkm, named 'وادي العزب'. An arrow points from this row to a corresponding feature on the map. The map shows contour lines, streams, and place names in Arabic, such as 'الخرف والسرن' and 'مروج الخواج الشهابية'. The status bar at the bottom indicates coordinates: 35.739 32.176 Decimal Degrees.

FID	* Shape	ID	Area_sqkm	Name
0	Polygon	125	136	وادي الباعج
1	Polygon	126	79	وادي الحجعة
2	Polygon	142	66	وادي الذبيقة
3	Polygon	150	149	وادي عظيم
4	Polygon	158	138	وادي الزعتري
5	Polygon	161	128	وادي الثلج
6	Polygon	168	242	وادي حميد
7	Polygon	173	252	مشائل فيصل
8	Polygon	174	128	وادي العزب
9	Polygon	179	150	وادي القهوجي
10	Polygon	180	130	وادي اللخفي
11	Polygon	190	231	وادي النقي
12	Polygon	191	52	كلمة نقا

Topographic maps 1:50000

Appending Attributes

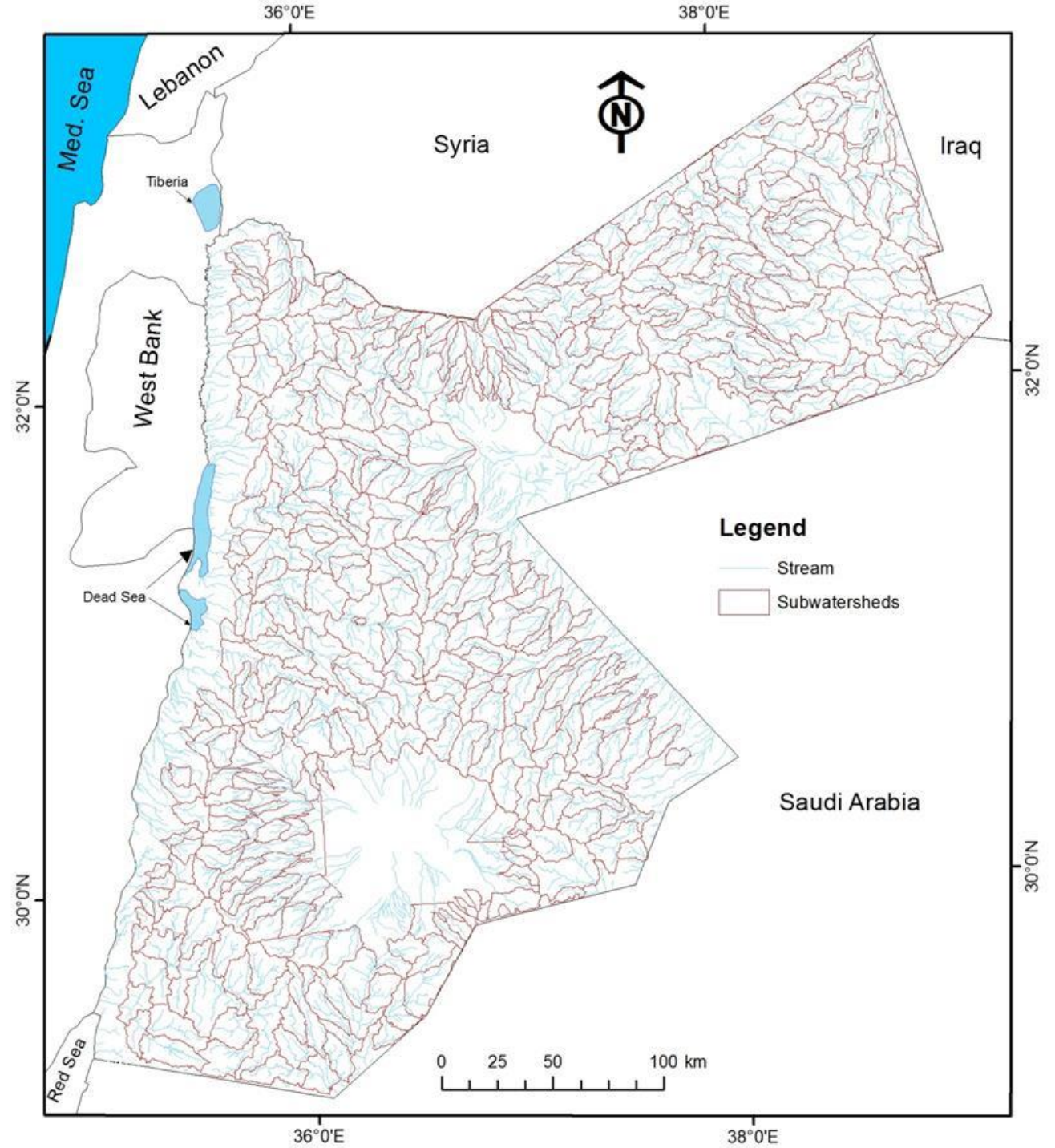
The screenshot displays a GIS application window titled "New Data Frame 2" on the left, listing various data layers. The "Zarqa_shds_GCS" layer is selected. The main area shows a map of the Zarqa Basin with red outlines for sub-basins and blue lines for streams. The sub-basins are labeled in Arabic: وادي الباعج, وادي الجبعة, وادي الذقانة, وادي عليم, وادي الزعترى, وادي الشلح, وادي حميد, وادي المشائل فيصل, وادي العرب, وادي السليبي, وادي الدق, وادي القهوجي, وادي التركبان, وادي السايح, وادي المريط, وادي ارمدان, وادي الماضونة, وادي الغباوي, and وادي اللخفي.

On the right, the "Attributes of Zarqa_shds_GCS" table is visible, showing the following data:

FID	Shape	ID	Area_sqkm	Name
0	Polygon	125	136	وادي الباعج
1	Polygon	126	79	وادي الجبعة
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11	Polygon	190	231	وادي الدق
12	Polygon	191	52	وادي التركبان

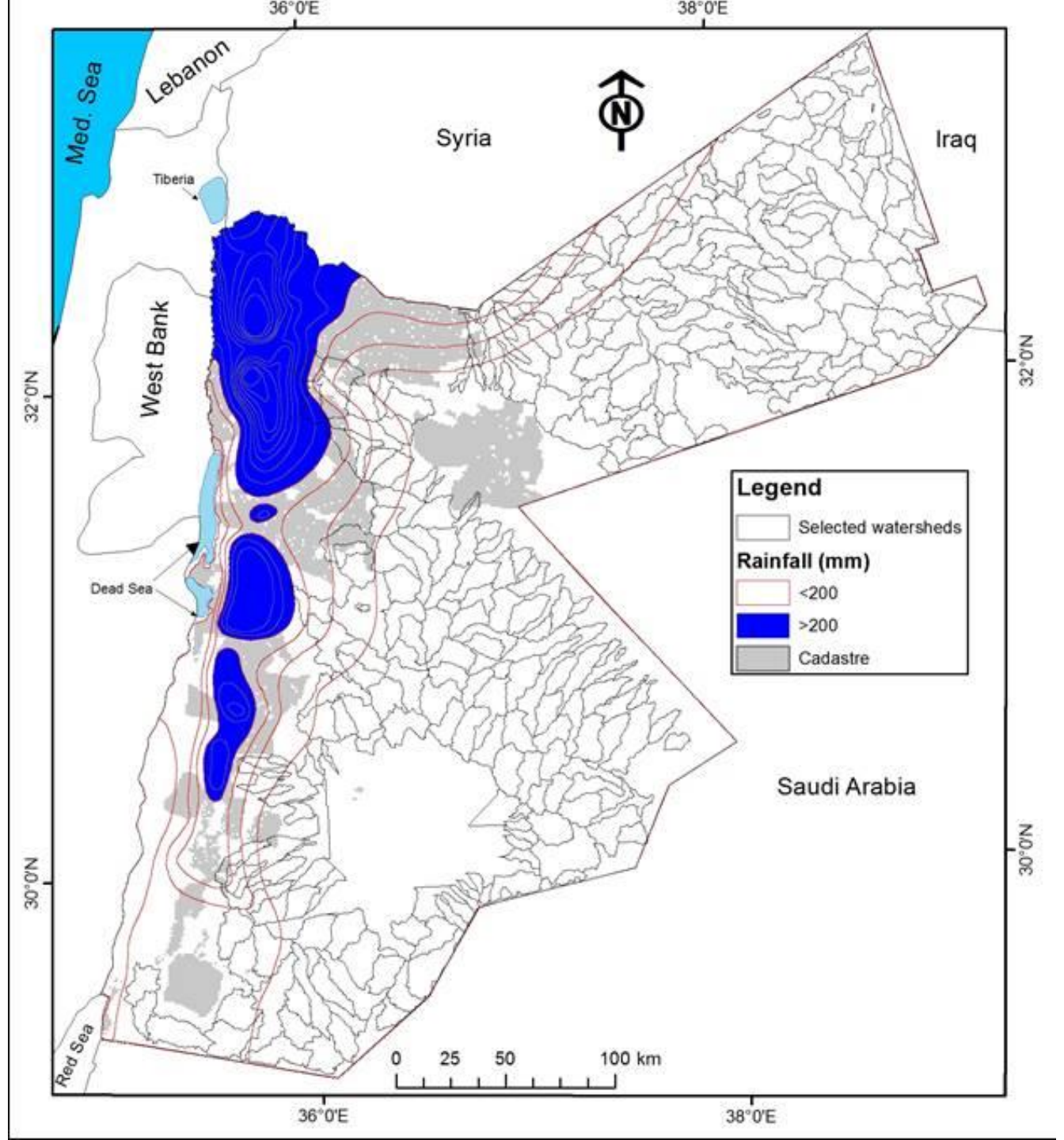
Zarqa Basin

441 subwatersheds
Average area 155 km²



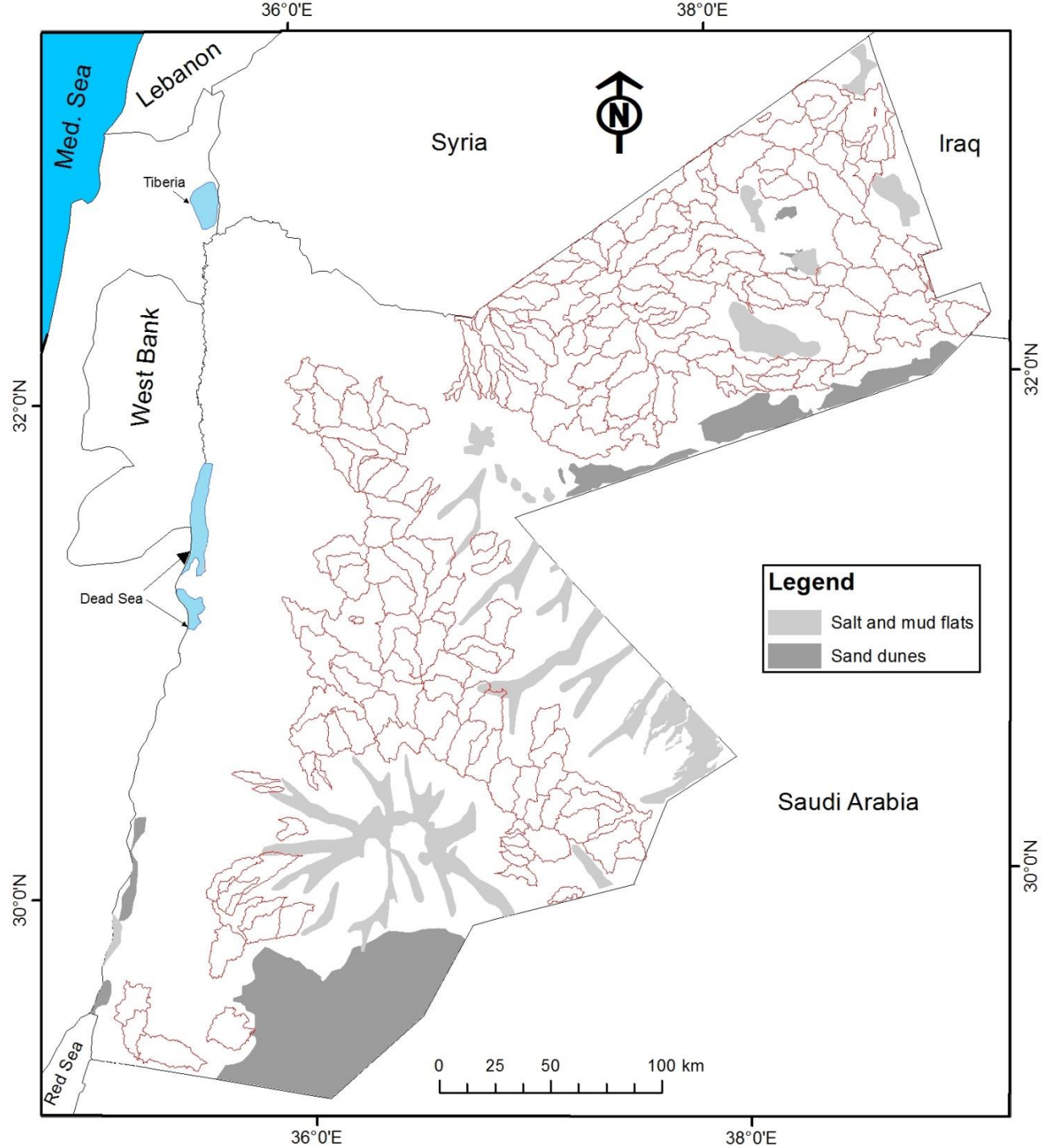
Refining selection: Rainfall and land tenure

323 subwatersheds



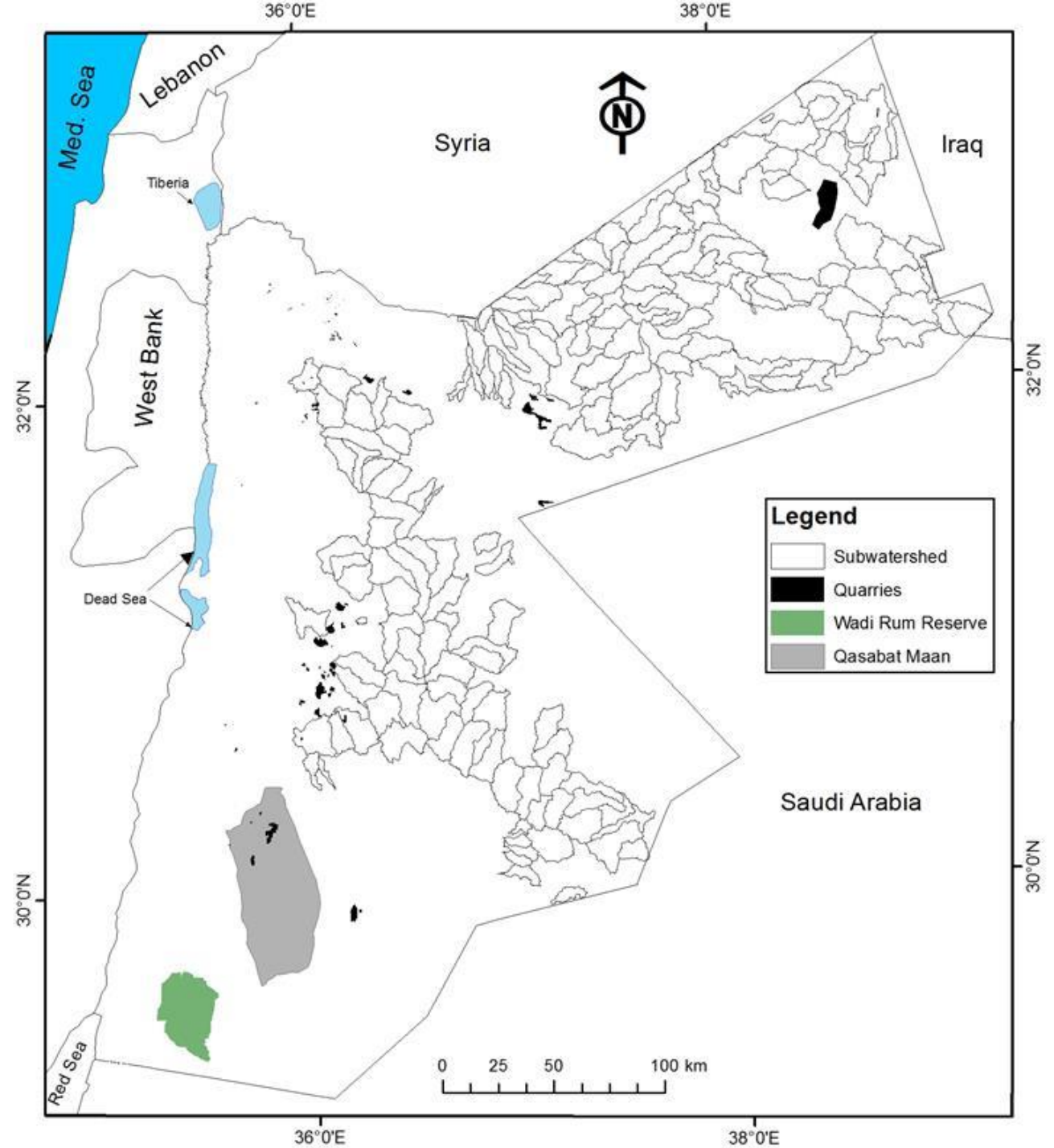
Refining selection: Soil limitations

204 subwatersheds



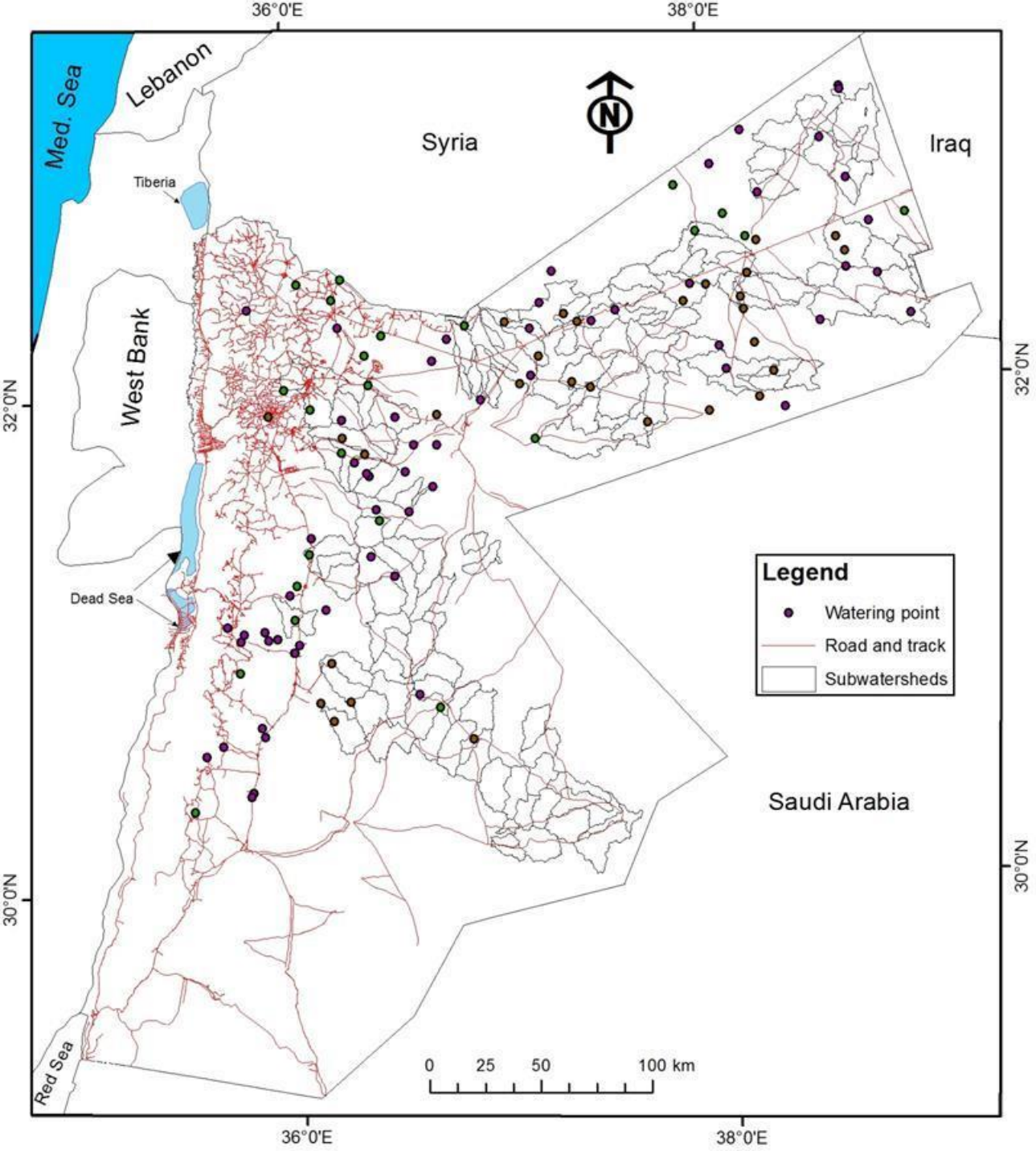
Refining selection: Existing and planned land use

181 subwatersheds



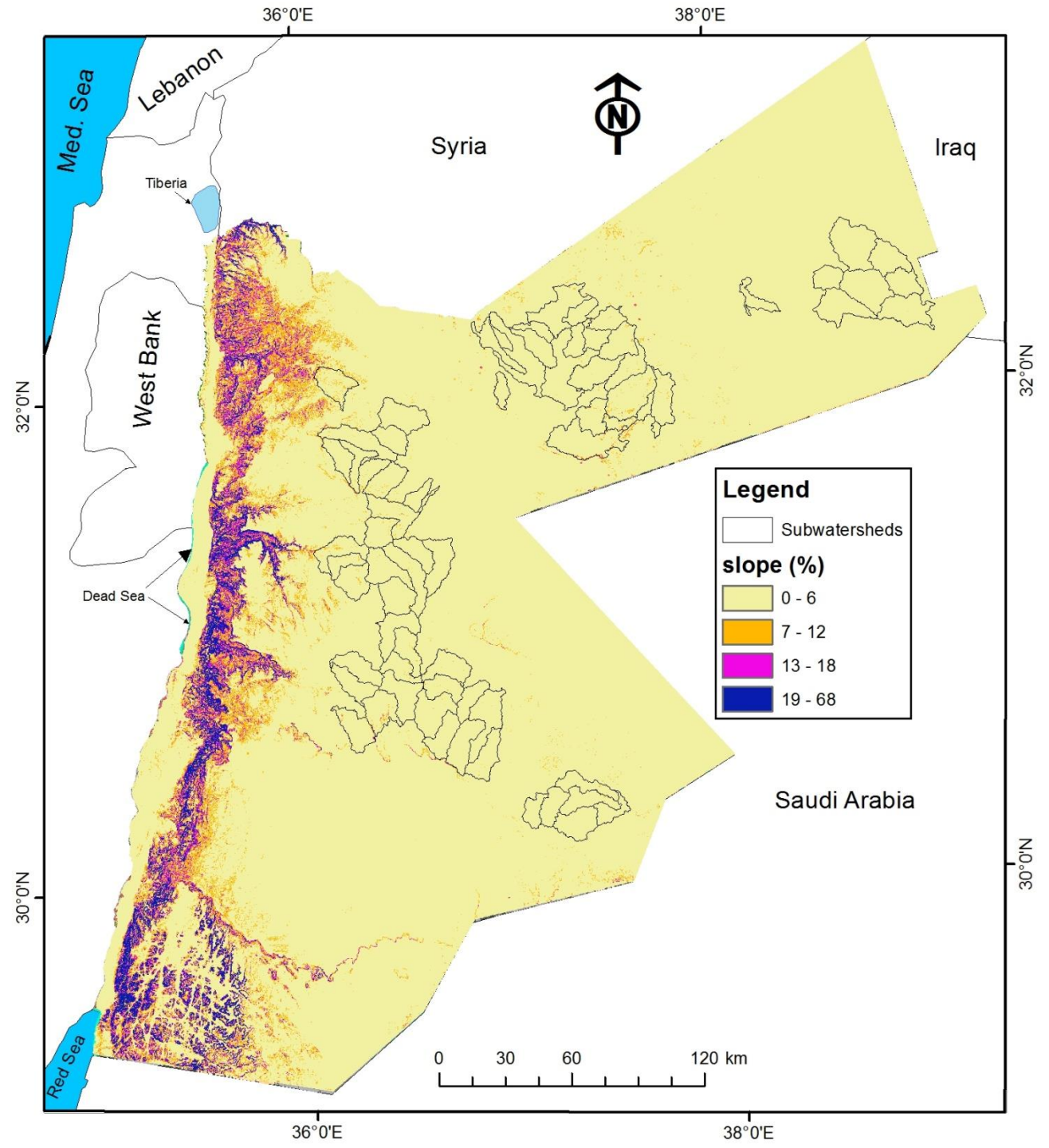
Refining selection: Accessibility and watering points

140 subwatersheds



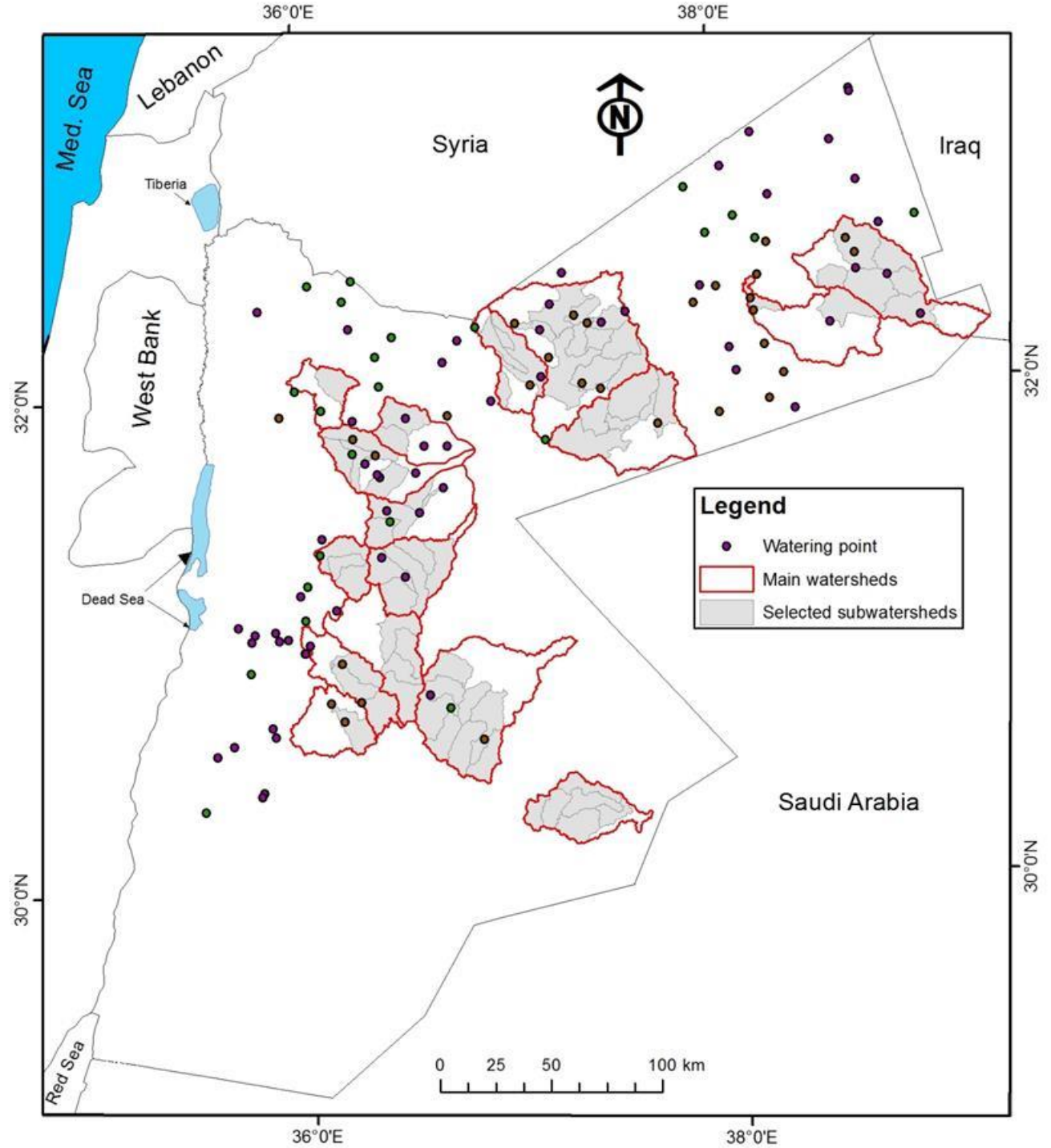
Refining selection: Topography and vegetation conditions

69 subwatersheds



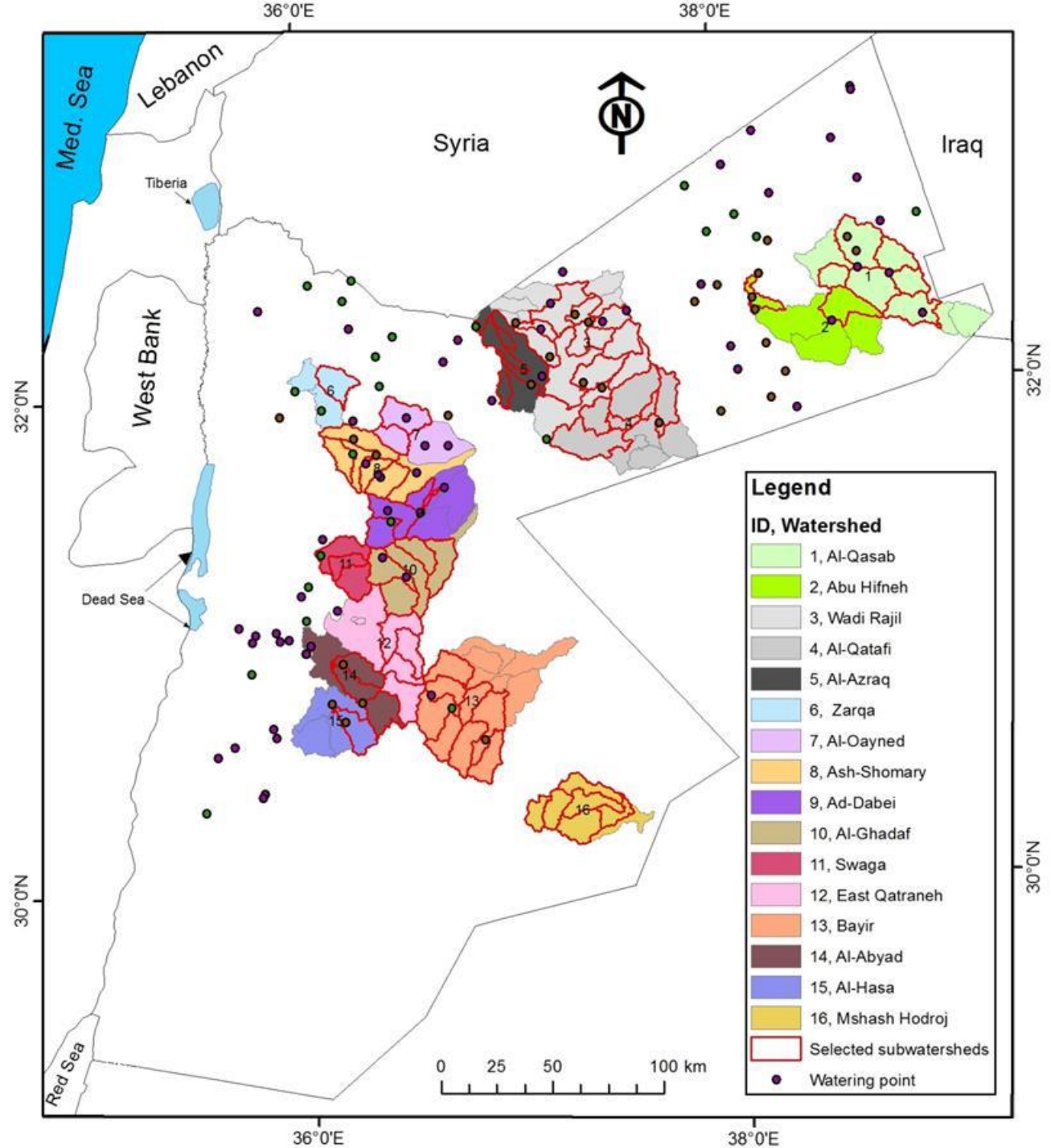
Selected Watersheds

16 watersheds
111 subwatersheds
69 initially selected sub.

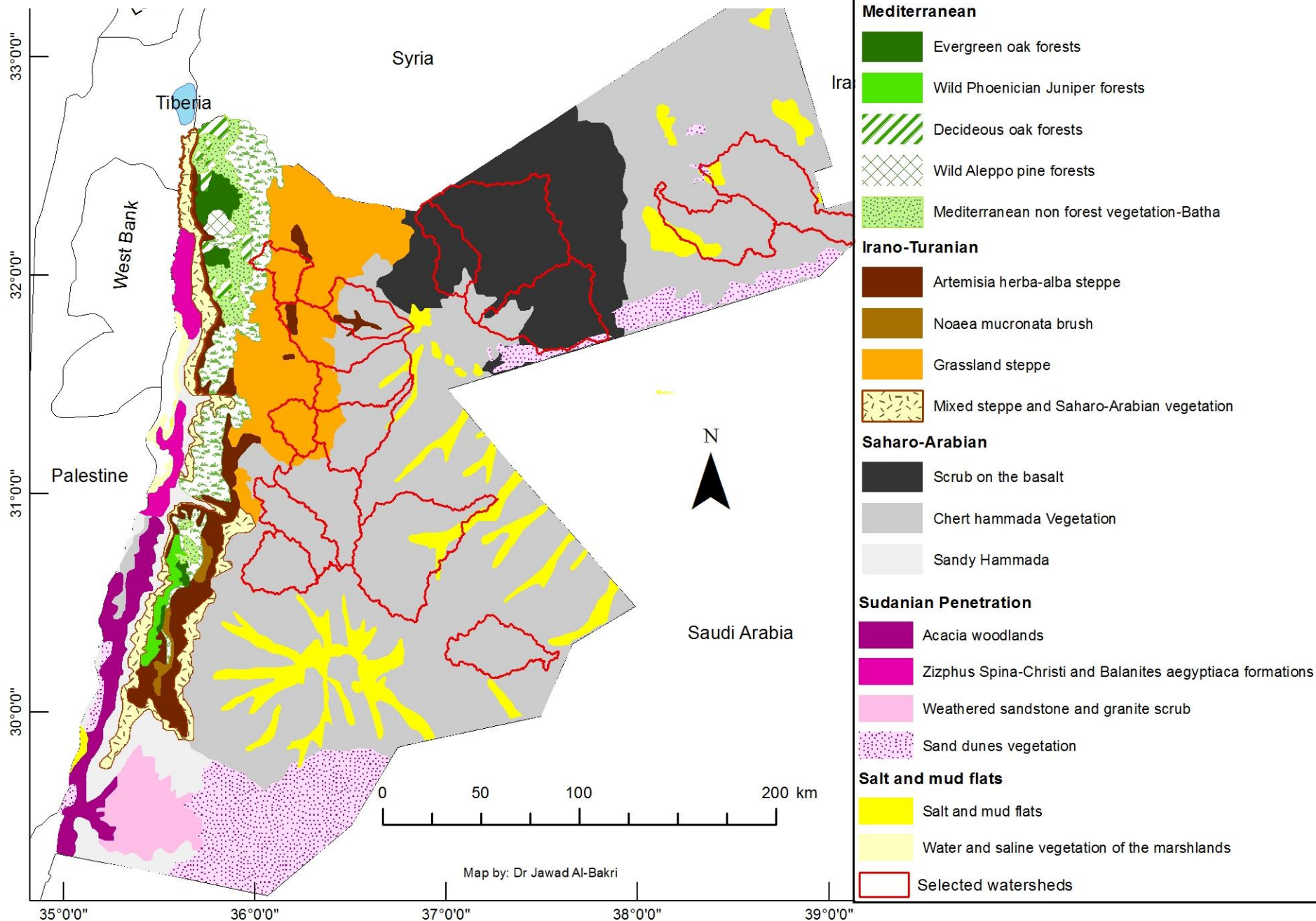


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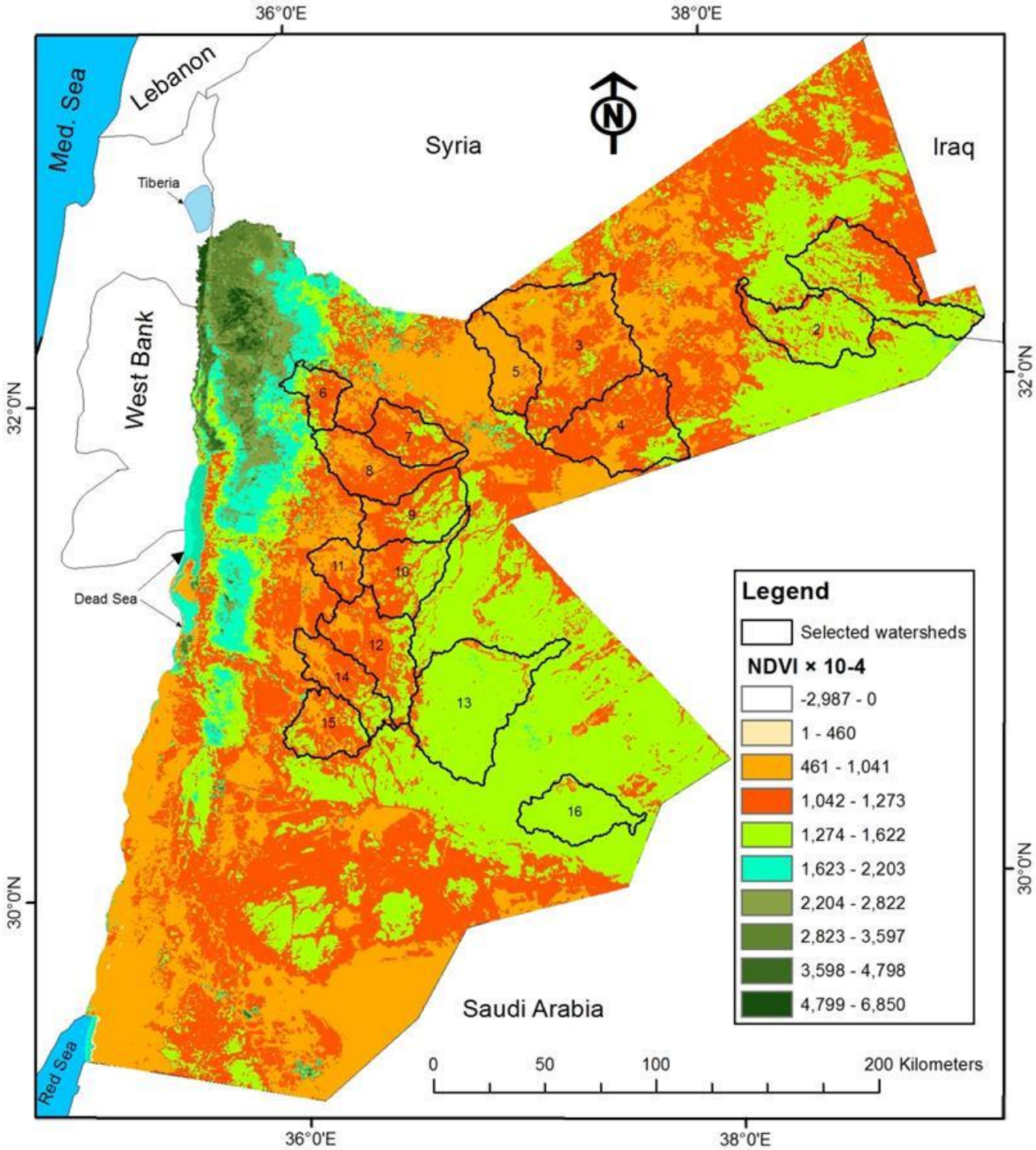


Characterization of Selected Watersheds



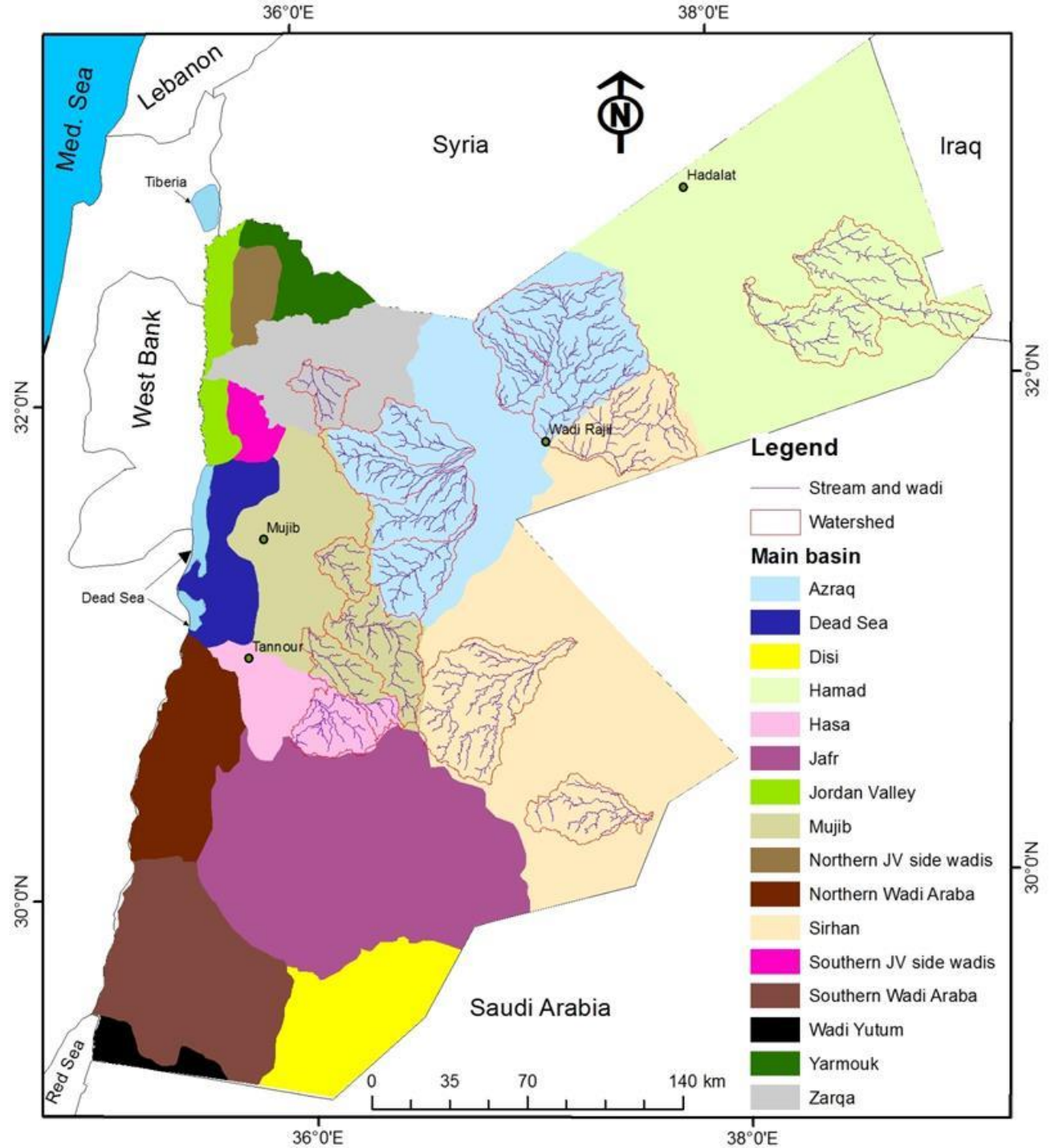
Characterization of Selected Watersheds

NDVI- 10 years average



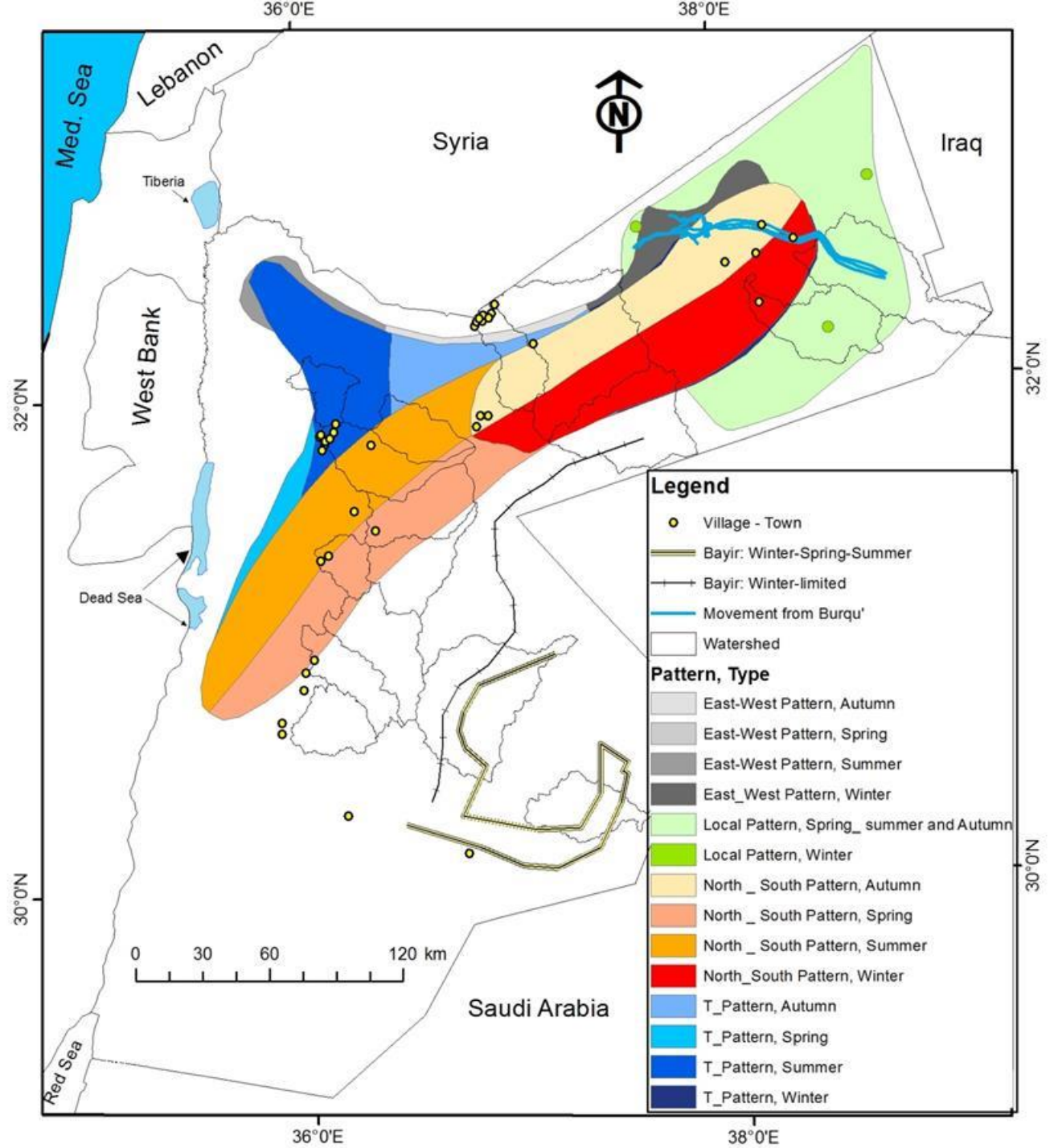
Characterization of Selected Watersheds

Hydrology



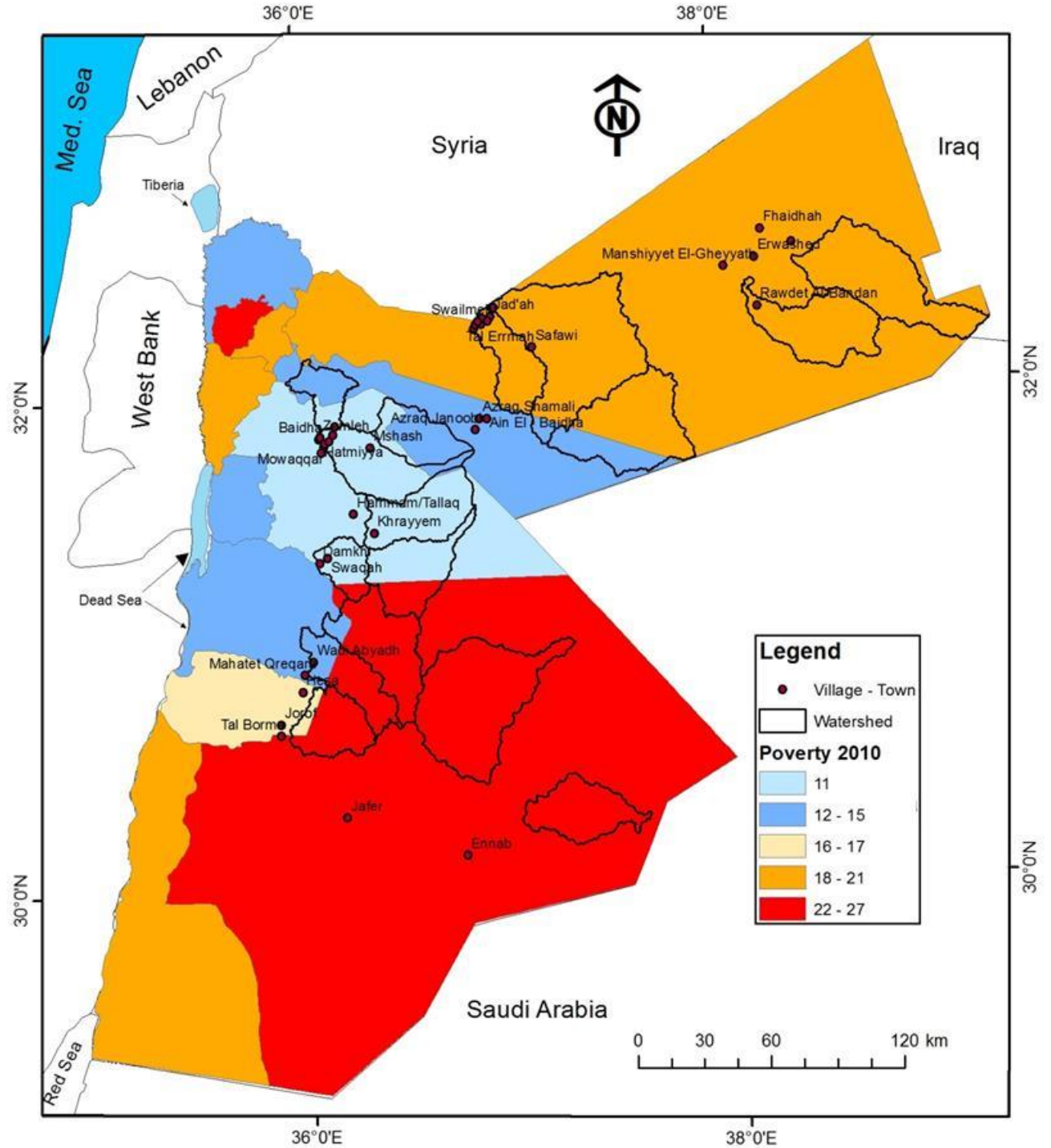
Characterization of Selected Watersheds

Grazing routes



Characterization of Selected Watersheds

Poverty levels



5. Conclusions

- The use of GIS based approach, coupled with ground survey is efficient. Detailed datasets are still needed.
- Dimension of soil and water conservation is under looked by the social and political dimension.
- Potential conflicts with future land use plans do exist.
- Detailed mapping of land degradation is still needed.
- Soil health and levels of soil recovery are not well documented.