Food and Agriculture Organization
of the United Nations

Jordan

LAND COVER ATLAS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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Abstract

The Jordanian land cover database and atlas were developed under the Regional Food Security Analysis Network (RFSAN) project. The main objective of the project is to increase and improve provision of goods and services from agriculture, forestry and fisheries in a sustainable manner as well as to increase the understanding of the bio-physical conditions of land in Jordan.

The Land Cover Atlas of the Hashemite Kingdom of Jordan provides information on the land cover distribution by sub-national administrative boundaries (governorates and districts) shared by the Royal Jordanian Geographic Centre (RJGC).

The Land Cover Database is compliant with the ISO\FAO standard (ISO 19144-2:2012) based on the Land Cover Classification System (LCCS): Land Cover Meta Language (LCML).[1] LCML was implemented to support the standardization and integration of a national land cover classification system across the world. It provides a set of standard diagnostic attributes that are independent of the scale of interpretation. Its use advocates for a more transparent and comparable way of reporting land cover information. The LCML land cover legend was designed with the software LCCSv3.[2]

The main data source includes multispectral Sentinel-2 imagery at 10 m of spatial resolution acquired from April to November 2016 and ancillary georeferenced data (land cover and land use map, vegetation cover, soil map) obtained from different institutions.

Sentinel-2 imagery were pre-processed and mosaicked to provide a temporal sequence of free-cloud, calibrated images. Then, an Object-Based Image Analysis workflow was applied to segment the images into homogeneous polygons, that were interpreted according to their spectral, texture and shape characteristics supported by vegetation indices and ancillary datasets. Post-processing finally removed incoherent classifications, clipping and dissolving polygons to official boundaries. The final database comprises 1 million polygons classified according to the LCCS Legend distinguished into 34 classes (23 aggregated classes).

The statistical analysis of land cover aggregated class distribution is organized into two sections:

- National Land Cover Database (LCDB).
- LCDB by governorates.

This work represents a substantial contribution to understanding land cover and land processes in the Hashemite Kingdom of Jordan and provides valuable baseline data to further monitor land changes in the future.

Mr René Castro-Salazar
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1 Land Cover Meta Language. https://www.iso.org/standard/44342.html

2 Land Cover Classification System. Classification concepts. Software version 3. http://www.fao.org/3/a-i5232e.pdf

Contents

List of tables, figures, maps

Tables

Maps

Figures

Foreword

The Hashemite Kingdom of Jordan is situated in Western Asia lying between latitudes 29° and 34° N and longitudes 34° and 40° E.

The geographical scope of the country, divided into 12 Governorates, covers about 89 287 square kilometres encompassing a wide area of climatic and ecological regions where the country's population (approximately 8 million out of which 1.3 million are Syrians) is largely concentrated in the west, northwest, inside and around the capital Amman, while a sizeable number reside in the southwest along the coast of the Gulf of Aqaba.[1]

The altitude of the country ranges from -430 m at the surface of the Dead Sea to the 1 854 m of Jabal Umm ad Dami with an average elevation of 812 m (2 664 ft). The geology includes basaltic rocks, sandstone, limestone, chalk, marl and chert and various Pleistocene and Holocene deposits, both of alluvial and eolian origin.[2] Extensive lava flows have occurred in the north of the country. This range in physical features has produced an equally wide range of soils and landscapes.

Jordan can be divided into four main geographic and climatic areas: the Jordan Valley, Mountain Heights Plateau, the eastern desert or the Badia region and the steppe region found between the Badia and the Highlands.

The climate in Jordan varies greatly. Western Jordan has a Mediterranean climate with a hot, dry summer, cool-wet winter and two short transitional seasons. About 75% of the country can be described as having a desert climate with less than 200 mm of annual rainfall. Placed as one of the ten most water-stressed countries in the world, Jordan contends with water pressure, a result of the country's aridity, recurring droughts and the demands of a rapidly growing population.[3] The country relies heavily on underground water to meet the demands of the population.

The Kingdom is prone to periodic droughts. The most recent and worst drought period the country faced was from 1998 to 2000, which caused severe economic and environmental losses. According to the Aligned Action Plan to Combat Desertification in Jordan, climate change is likely to increase the country's exposure to drought and may adversely influence vulnerable ecosystems like forests and fresh water communities.[4]

Agriculture plays a significant role in food security and continues to be a source of hard currency, which comes from exporting fresh fruits and vegetables. Due to the country's climatic conditions, the production of wheat and barley are marginal and are considered of little value. Indirect contributions that stem from agricultural linkages to auxiliary industries such as food processing, agribusiness and fertilizer account for 27 percent of the country's gross domestic products. The majority of the rural population relies on agriculture for their livelihoods.[5] Approximately 20 percent of the country's poorest people live in rural areas and are directly or indirectly dependent on agriculture for livestock, smallholder farming and employment.[6]

In line with the Country Programming Framework (CPF) 2016-2020, FAO's assistance in Jordan focuses on four priority areas for technical cooperation:

- Promoting climate-smart agriculture and community-based natural resource management.
- Enhancing rural and peri-urban livelihoods through improved generation of incomes, employment and access to safe and nutritious food.
- Improving production, post-harvest management, domestic marketing and export of safe, quality Jordanian agricultural products.
- Enhancing disaster risk reduction at household, community and national level.

In this context, the land cover mapping of Jordan is an essential requirement that aims to:

- Generate an integrated, geo-referenced, updated Land Cover Database in conformance with international standards.
- Provide detailed base information on the conditions and hazards of natural resources.
- Support several activities, projects and agro-environmental studies.
- Make spatial data functional, available and at the service of natural resources management, agricultural practices, risk management and sustainable production.

1 CIA World Factbook

2 Bender 1964, 1974

3 Drought conditions and management strategies in Jordan, 2014. WMO, UNCCD, FAO and UNW-DPC

4 The Aligned Action Plan to Combat Desertification in Jordan 2015 – 2020.

5 Updated Rangeland Strategy for Jordan. Ministry of Agriculture. 2014

6 Jordan and FAO, Partnering for resilience and sustainable food security. http://www.fao.org/3/aaz572e.pdf

Acknowledgements

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This activity was implemented in close collaboration with the Ministry of Agriculture (MoA) and the Royal Jordanian Geographic Centre (RJGC) with the participation of other national institutions: the National Agricultural Research Center (NARC), the Agricultural Credit Corporation (ACC), the Department of Statistics (DoS) and the Jordan Meteorology Department (JMD). Additional technical support was provided by the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO).

Legend development, image and segmentation, processing, interpretation, harmonization, database creation and map production activities were supported by national and international experts including:

- FAO's Geospatial Unit, currently managed by Douglas Muchoney, has been technically supported by Gianluca Franceschini, Emanuela De Leo and Francesca Pretto. Lucia Moro developed the graphic concept design of the Atlas. Antonio Di Gregorio provided technical assistance.
- FAO Jordan led by the representative Nasredin HagElamin. The project coordination in Jordan was carried out by Rene Verduijn (FAO, Chief Technical Adviser) and Craig von Hagen (iMMAP, Lead Technical Expert).
- FAO Regional Office for Near East and North Africa (RNE) supported by Ayman Omer (FAO RNE, Senior Field Programme Officer).
- The Royal Jordanian Geographic Centre (RJGC) led by Dr. Awni Moh'd Kasawneh (Director General/ Brigadier General).
- The SUPARCO team led by Imran Iqbal with the support of Abdul Ghafoor, Zafar Iqbal, Ijaz Ahmad, Iftikhar Bhatti, Riffat Shamshad, Muhammad khan, Muhammad Ibrahim and Bilal Aslam.

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Acronyms

ACC
Agricultural Credit Corporation

ASTER
Advanced Spaceborne Thermal Emission and Reflection Radiometer

CBDS
Climate Biodiversity land and water Department - geoSpatial Unit

CPF
Country Programming Framework

DOS
Department of Statistics

ESA
European Space Agency

FAO
Food and Agriculture Organization

IMMAP
Information Management and Mine Action Programs

ISO
International Standards Organization

JMD
Jordan Meteorology Department

JOSCIS
Jordan Soil and Climate Information System

LC
Land Cover

LCCS
Land Cover Classification System

LCDB
Land Cover Database

LCML
Land Cover Meta Language

MOA
Ministry of Agriculture

MSI
Multi Spectral Instrument

NCARE
National Center for Agricultural Research and Extension

NDVI
Normalized Difference Vegetation Index

NSM&LUP
National Soil map and Land Use Project

OBIA
Object-Based Image Analysis

OSM
Open Street Map

RFSAN
Regional Food Security Analysis Network

RJGC
Royal Jordanian Geographic Centre

RVI
Ratio Vegetation Index

SUPARCO
Pakistan Space and Upper Atmosphere Research Commission

USAID
United States Agency for International Development

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Executive summary

Jordan is a resource-constrained country, challenged further by desertification, drought and land degradation. Seventy-five percent of the country is arid and less than five percent of its total land area is arable. Jordan experiences periodical drought and is considered the third most water-insecure country in the world. Additional pressures of population growth, unsustainable land use, urbanization, industrialization and climate change threaten to exacerbate and increase vulnerabilities in agriculture, livelihoods, nutrition and food security and environmental sustainability.

Within this context and considering the widening gap between ecological capacity and demand, there is a great need to encourage actions to collect evidence-based data to support climate change mitigation and adaptation, rehabilitation and preservation of Jordan's natural resources. Efficient management of land and natural resources requires land cover mapping, a process that observes the physical cover of the earth and quantifies land resources and classifies them into a series of land cover types. Understanding land cover, and monitoring and measuring land changes over time, is fundamental to institutions and individuals who are in land management roles and are at the forefront of sustainable management of natural resources, the protection of the environment and sustainable agricultural production.

Land cover is an indicator of both the physical and socio-economic status of the country; it provides accurate information on the actual state of agriculture, forest/rangeland and natural vegetation cover and the levels of development, degradation and the potential for rural development and agricultural production. In addition, land cover information clearly shows the population pressure on land and provides information on main agro-information systems and infrastructure development.

The land cover mapping project is a joint initiative within the Regional Food Security Analysis Network (RFSAN), a partnership between FAO and iMMAP; the FAO Geospatial Unit (CBDS), in collaboration with the Jordan Ministry of Agriculture (MoA), the Royal Jordanian Geographic Centre (RJGC), the Department of Statistics (DoS), the Jordan Meteorology Department (JMD) and the National Centre for Agricultural Research and Extension (NCARE). The project supports Jordan's broad vision of achieving productive and sustainable use and management of land resources to enable poverty reduction, environmental sustainability and to strengthen the national economy.

In accordance with FAO methodology and the International Standards Organization (ISO), the steps used to define Jordan's land cover included satellite imagery, satellite image segmentation and classification, definition of land cover classes and field verification. The project describes the vegetation status and its dynamics, including crops and natural vegetation, using the new generation satellite imagery from the European Space Agency (ESA) and applying innovative methodology that integrates segmentation and analysis of the Normalized Difference Vegetation Index (NDVI). The work was carried out in three main phases: Sentinel-2 Image selection, acquisition and processing; preliminary analysis of the area of interest, agro-ecological and physiographic characterization; analysis of NDVI series within segmentation. A total of 34 land cover classes are defined, which have been aggregated into 23 main classes.

The use of land cover mapping and land cover change monitoring in Jordan can assist in and contribute to the following:

- Guiding the development and implementation of policies and legislations
- Efficiency in agricultural production, sustaining long-term production while preserving the environment
- Land use and management
- Combating desertification, land degradation and drought
- Forest monitoring
- Food security/Early Warning Systems
- Water management and soil protection
- Urban planning
- Disaster Risk Management (floods, fires, subsidence and landslides)
- Terrestrial mapping for humanitarian aid and development.

Section 1

National LCDB

1 Introduction

Land cover (LC) can be defined as the "observed (bio)physical cover of the earth's surface", and is a synthesis of the many processes taking place on the land. It reflects land occupation (and its transformation) by various natural, modified or artificial systems and to some extent how these systems affect the land. LC is one of the most easily detectable indicators of human intervention on land. Because it can change quickly over time, it is also a good proxy for dynamics of the Earth surface resulting from a variety of drivers and factors.[7]

Assessment of land cover and land cover change are essential requirements for the sustainable management of natural resources, environmental protection, food security and humanitarian programmes, as well as core data for monitoring and modelling. Land cover data are therefore fundamental to fulfilling United Nations mandates, international and national institutions and many programmes.

The FAO's Geospatial Unit has recognized the value of land cover mapping with an operative and effective classification system. It has fully supported activities concerning the definition of the standards. It contributes to an accurate assessment of the land cover types that can be applied and exploited in many environmental and planning activities.

Mapping land cover triggers several connected actions to increase awareness, contribute to the development of capacities and facilitate the exchange of knowledge and technologies among stakeholders for the sustainable management and use of natural resources.

In this dynamic world, land cover/land use change are directly and indirectly affecting the environment and climate at global, regional and national levels. The land cover and land use assessment provide science-based evidence to support policy decisions and management processes. Survey data is time consuming and costly, while satellite imagery can be used to monitor the spatial extent of changes in land cover or land use.

2 Land Cover Mapping of Jordan
using FAO methodology

2.1 General

The FAO methodology for Jordanian land cover mapping is based on the following main steps:

- Selection, pre-processing and multi-temporal analysis of remote sensing imagery.
- Definition of the land cover legend in LCML in close collaboration with the national organizations considering their familiarity with the environment.
- Segmentation of selected imagery for the automatic creation of the vector baseline for interpretation.
- Land cover interpretation using a semi-automatic/visual procedure for pre-labelling based on the multi-date imagery.
- Integration and ingestion of field data for correction of misinterpretation and enrichment of the database.
- Creation of land cover maps, statistics and an atlas.
- Training and workshop to provide necessary capabilities for management, maintenance, upgrading, access and dissemination of the land cover database.

2.2 Satellite Imagery

2.2.1 General

Satellite imagery offers spatial coverage, along with high revisit capabilities, providing statistical information and making it possible to monitor the different land cover features. Remote sensing technologies have made a substantial contribution to deriving land cover information and correlating it to land-use statistics. Availability of satellite images with different spatial and temporal resolutions have made it possible to map land cover at different scales and carry out analyses of the changes with reference to past decades.

2.2.2 Sentinel 2 imagery

The land cover of Jordan was developed based on the interpretation of the Sentinel-2 satellite data, a combination of imagery from the sentinel-2A satellite launched on 23 June 2015 and Sentinel-2B in mid-2016. The imagery from these satellites supports the study of land cover/land use and change detection, leaf area index, leaf chlorophyll content and leaf water content.

7 **Di Gregorio, A. 2016.** *Land Cover Classification System, Software version 3.* Available on http://www.fao.org/3/a-i5232e.pdf (accessed on 10 May 2017).

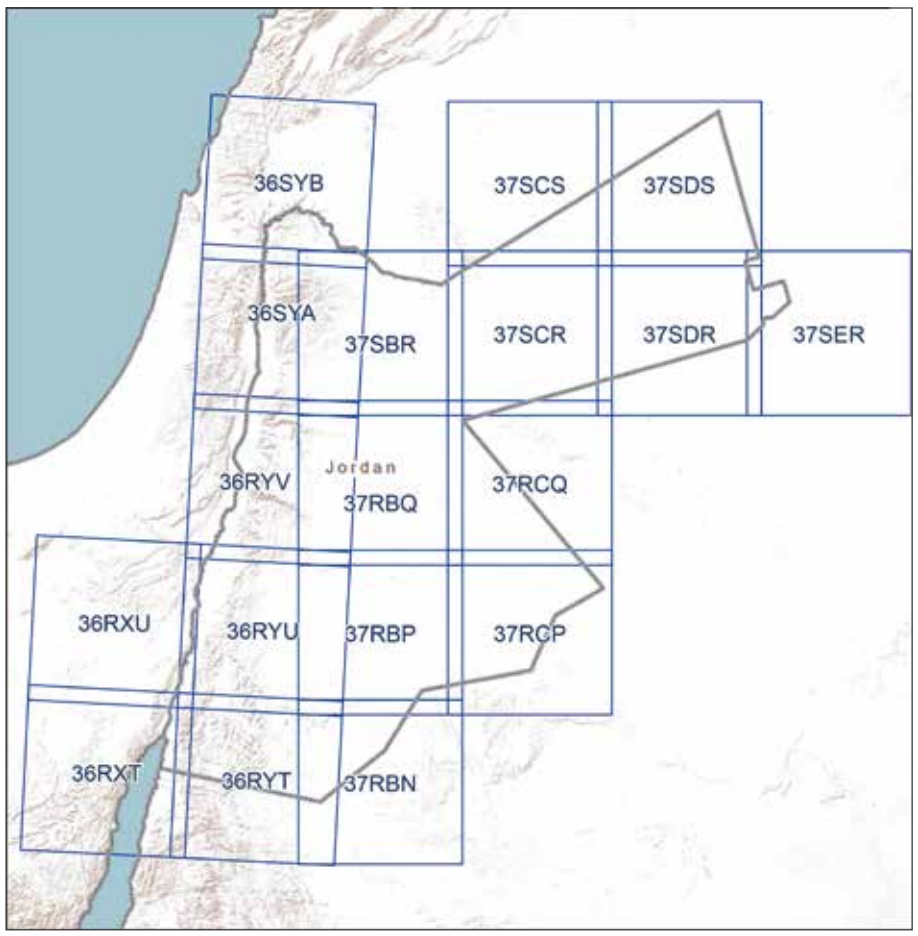


Figure 1. Ground coverage of Sentinel-2 10m employed in the generation of the land cover map 2016

Sentinel-2 has a 290 km swath with revisit frequency of five days for a constellation of two satellites and ten days for one satellite. The Sentinel-2 Multi Spectral Instrument (MSI), having the span of 13 spectral bands from the visible and the near infrared to the shortwave infrared at different spatial resolutions ranging from 10 to 60 metres on the ground, is used for global land monitoring, emergency management, security and climate change analysis.

The four bands at 10 m resolution[8] ensure continuity with missions such as SPOT-5 or Landsat-8 and address user requirements, in particular, for basic land cover classification.

The six bands at 20 m resolution[9] satisfy requirements for enhanced land cover classification and for the retrieval of geophysical parameters.

Bands at 60 m spatial resolution[10] are dedicated mainly to atmospheric corrections and cirrus-cloud screening. Different surface types such as water, bare ground and vegetation reflect radiation differently, captured by the different channels of the MSI and then used to discriminate land features. The radiation reflected as a function of the wavelength is called the spectral signature of the surface.

The Sentinel-2 images attained for the generation of LCDB comprises 18 tiles (including a 5 km country buffer) acquired monthly from April to November 2016. Sentinel-2 single bands were pre-processed to generate monthly free-cloud 3-band mosaics.

The chlorophyll in a growing plant absorbs the visible light, especially in the red spectrum (band 4 of Sentinel-2) to be used in photosynthesis, whereas near infrared (band 8 of Sentinel-2) is reflected very effectively. This behaviour is particularly effective to reveal how large a part of the area is covered with growing green leaves.

The mathematical combination or transformation of spectral bands enables the calculation of vegetation indices that are the key to automatically identifying different land cover classes, as well as the greenness, density and health of vegetation.

The multi-temporal analysis of Sentinel-2 imagery was undertaken to compute the Ratio Vegetation Index (RVI) and the Normalized Difference Vegetation Index (NDVI).

RVI=NIR/RED
NDVI=(NIR–RED)/(NIR+RED)

The RVI was computed in April to discriminate among three macro classes (water, bare areas, vegetated areas) while the multi-temporal monthly NDVI trend (from April 2016 to November 2016) was helpful to analyze the growing cycle of vegetation and assist in the phase of interpretation.

8 Band2 - Blue (490 mm), Band3 - Green (560 mm), Band4 - Red (665 mm) and Band8 - NIR (842 mm).

9 Band5 - Vegetation Red Edge (705 nm), Band6 - Vegetation Red Edge (740 nm), Band7 - Vegetation Red Edge (783 nm), Band8A - Vegetation Red Edge (865 nm),Band11 - SWIR (1610 nm), Band12 - SWIR (2190 nm).

10 Band1 - Coastal aerosol (443 nm), Band9 - Water vapour (945 nm), Band10 - SWIR Cirrus (1375 nm).

Figure 2. EXAMPLE: Multi-temporal analysis of features in Sentinel-2 scene.

2.2.3 The Land Cover Classification System (LCCS) and the land cover legend

Understanding landscape patterns and changes requires an agreement on the terminology of land resources. In order to address the harmonization and standardization of data collection, FAO and UNEP collaborated in the early 90s to review the land cover classification systems in use. This work progressively led to the definition of a Land Cover Classification System (LCCS),[11] and finally in 2012 to the definition of a joint standard between FAO and ISO on the Land Cover Meta Language, published as ISO document 19144-2:2012.

Land Cover Meta Language (LCML) is a modern approach in land cover classification to standardize the attribute terminology rather than the final classes of a legend. All rules and conditions of the meta-language have been installed in the user-friendly software LCCS3 that allows the creation, editing and export of LCML-based legends.

The Jordanian land cover legend (see page 9) was compiled in close consultation with representatives of esteemed agencies from Jordan (RFSAN, MoA, RJGC, DoM, NCARE, DoS). Their valuable contribution has made it possible to assemble detailed information regarding complex natural systems such as mudflats, wadis, rangeland and agricultural classes. Based on the visual interpretation of satellite imagery and previous land use maps, along with ancillary information, 34 land cover classes have been defined, aggregated into 23 major classes.

Although not useful for many applications, the choice of maintaining a large number of disaggregated classes, in particular on bare land (eight different classes), was taken to preserve the homogeneity of the features mapped.

The preliminary legend included the vineyards class, though vineyards are poorly representative in the final database in terms of number of polygons. Therefore, it was decided to suppress this class and include these polygons in the class "Irrigated orchards". The low number of polygons mapped as vineyards was due to the limitation of the imagery at 10 m resolution that does not allow the classification of different species of plant (e.g. vineyards and other shrub crops, or different fruit trees).

11 Land Cover Classification System Classification concepts and user manual Software version (2) http://www.fao.org/docrep/008/y7220e/y7220e00.HTM

2.2.4 Satellite image segmentation

The fundamental step of any Object-Based-Image Analysis (OBIA) is the segmentation of a scene. Image segmentation is the technique of portioning a digital image into spectrally homogeneous regions or image objects. The segmentation produces a vector layer of image objects that are then interpreted, meaning a land cover code assigned to each polygon.

In spatial pattern recognition, the decision rules are based on the geometric shape, texture, and patterns of pixels or objects. The testing procedure is a fundamental step to find the optimal balance between the final number of polygons and the level of detail required in delineating land cover features.

The segmentation was performed by using dedicated commercial software and a specific procedure was implemented to match the detail of the segmentation (i.e. the number of polygons) with the land (high in vegetated areas and low in bare land).

The resulted vector layer (97 567 polygons) was divided into fifteen tiles to facilitate the image interpretation among the interpreters. A generalization procedure was implemented on each tile to reduce the image size without affecting the original and to standardize the features that were created at different scales. The simplification tolerance was set at 20 m.

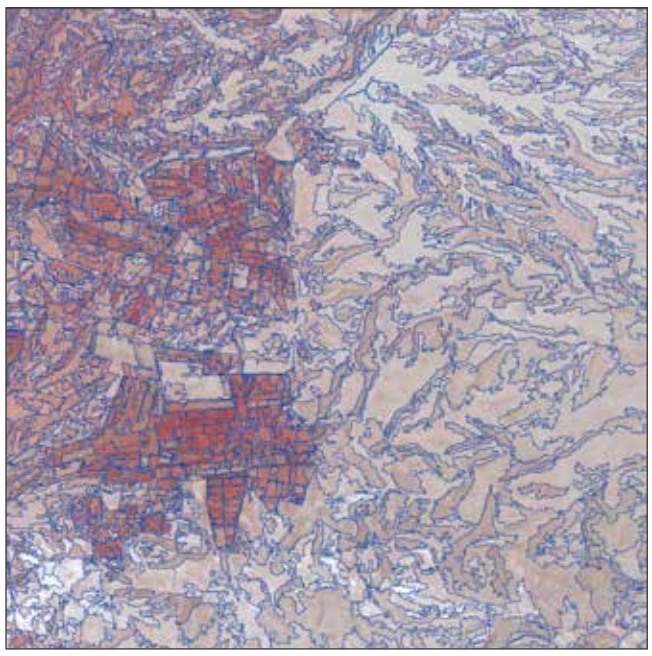


Figure 3. Reducing redundancy of polygons in bare areas.

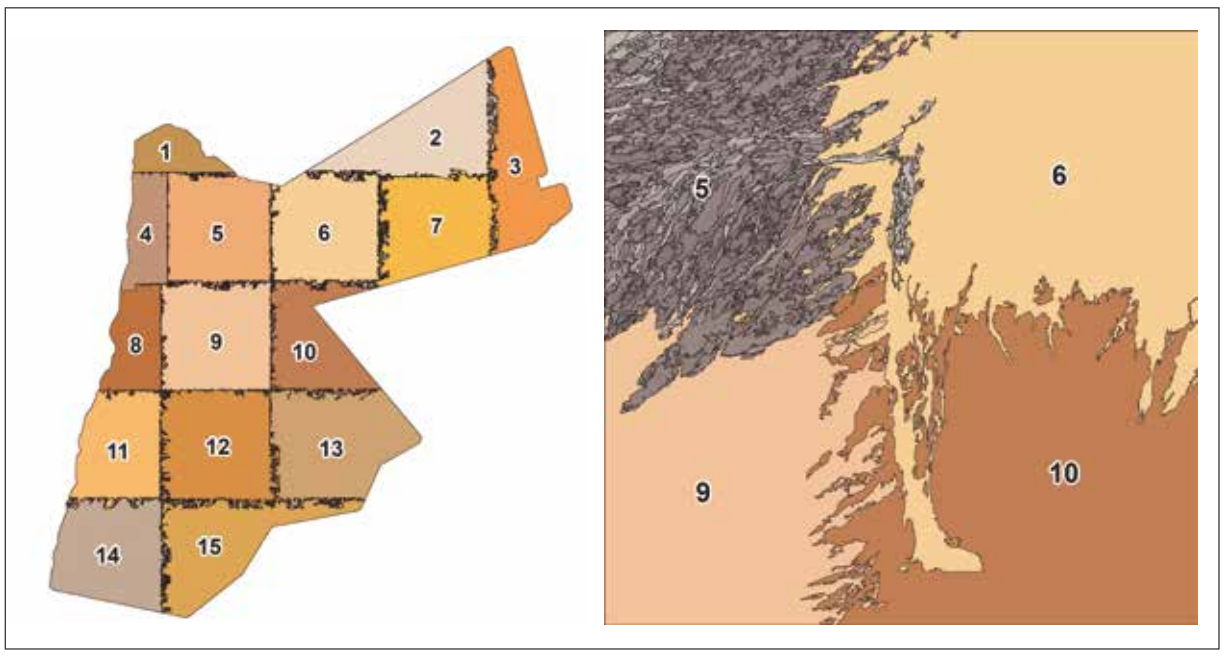


Figure 4. Layout of the 15 segmentation tiles, used in the Jordanian. LC mapping.

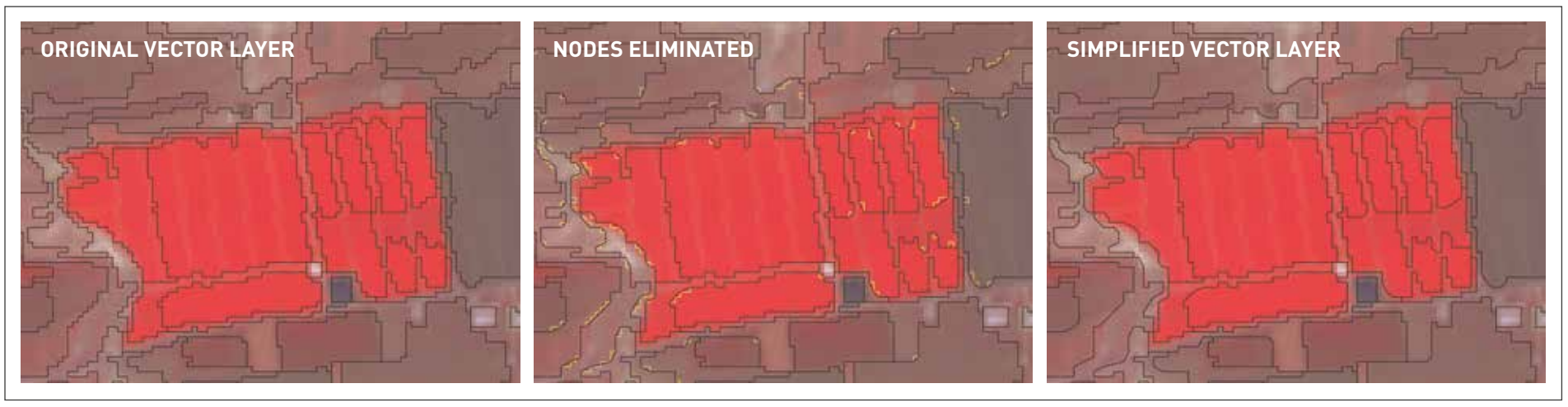


Figure 5. Detail of vector simplification. In yellow the nodes cut off in the procedure.

2.2.5 Image interpretation

During the image interpretation phase, the individual polygons are labelled with a land cover code. Two distinct techniques are used. First, in the visual interpretation step, a photo-interpreter assigns a code based on features' attributes and overlain with very high-resolution images (available in Google Earth). Second, in the automatic process, the code is assigned based on defined thresholds of feature attributes in each polygon (e.g. thresholds of a vegetation index).

The 80% of land cover mapping of Jordan was performed by visual interpretation, the remaining 20% by automatic labelling using multi-temporal NDVI profiles from April to November 2016.

2.2.6 Harmonization

Harmonization is the process of adjusting differences and inconsistencies among the different interpretation layers within the country to consolidate the fifteen tiles in one consistent final dataset. The harmonization is essential to generate a consistent land cover model of the country minimizing the differences and subjectivity of the different interpreters. It represents a sensitive phase in the land cover database generation and comprises the following activities:

- Harmonization of the land cover interpretation carried out by different interpreters, particularly on edges of different tiles;
- Quality check of the vector datasets to assure the thematic and topological integrity of the dataset.

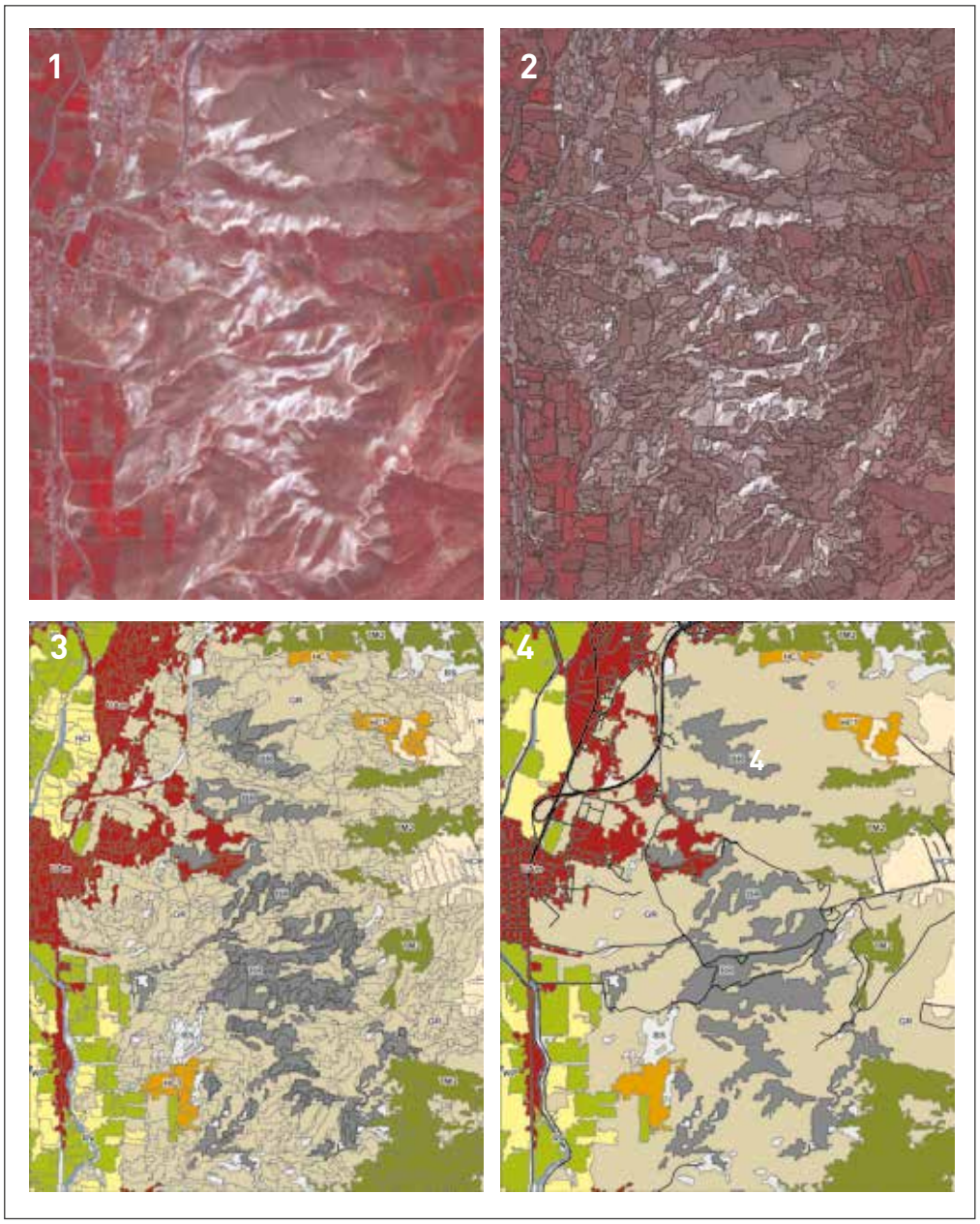


Figure 6. Sequence of activities, scene selection, segmentation, labelling, map generation.

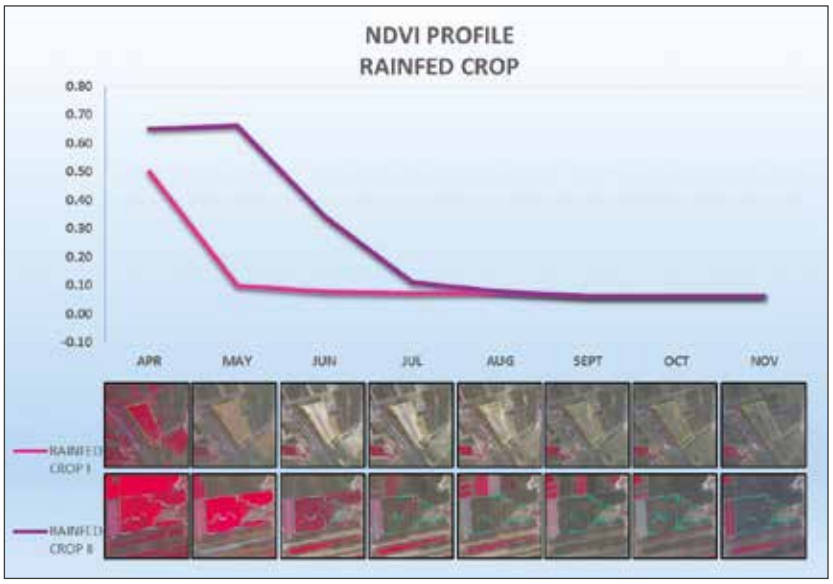


Figure 7. NDIVI profile - Some rainfed crops (type I and II) are characterized by monoculture. The NDVI profile, strictly depended on rainfall pattern over the year, shows a peak in April/May followed by a progressive reduction because of the climate's dryness.

Figure 8. Irrigated crops have higher and multiple peaks of NDVI compared to non-irrigated crop because of the continuous water supply.

2.2.7 Accuracy Assessment

The accuracy assessment of the final product is a fundamental and often neglected step in map generation. A land cover map may be considered accurate if it provides an unbiased representation of the land cover of the region it portrays. A classification error is thus, some discrepancy between the situation depicted on the thematic map and the reality. The most commonly used method to evaluate the accuracy in land cover maps is the confusion matrix, a quantitative method that compares the classification by interpreters to the referenced classification considered to be correct. The reference map may be generated from high-resolution imagery such as aerial photography, airborne video, ground observation and/or ground measurement. In the case of Jordan, the accuracy assessment was undertaken through random stratified pseudo-ground truth square samples validated using data hosted by Google Earth. Squared samples of 50 m sides were generated for each land cover class with a minimum of 51 samples per class. In total, 1734 samples were generated, converted to KML format and opened in Google Earth. The validation process was undertaken in Jordan during a national consultation workshop, where local experts reinterpreted the samples without prior knowledge of the initial land cover dataset. Then, the data were collated, cleansed, and statistical analysis performed. The accuracy parameters calculated are:

- Overall accuracy: proportion of correctly classified land cover. Sum of the correct classifications (diagonal elements) divided by the number of samples (1734).
- User's accuracy: per class probability that a sample unit in the map belongs to the same class on the ground. The diagonal elements are divided by the classification total.
- Producer´s accuracy: per class probability that a unit on the ground is classified in the same class on the map. The diagonal elements are divided by the reference total.

The overall accuracy is obviously dependent on the number of interpreted classes. By increasing the thematic detail, inevitably the overall accuracy tends to decrease for spectrally similar classes. Merging similar classes increases the overall classification accuracy.

TABLE
Confusion Matrix

	Basaltic plain	Bare	Chert plain	Woody vegetation	Irrigated orchards	Extraction site	Grassland sparse	Herb. crop irrigated	Herb. rainfed crop	Herb. crop + orchard	Industrial areas	Dry mudflat	Wet mudflat	Sparse woody vegetation	River	Salt evaporation ponds	Sandy areas	Saline soil	Closed trees	Open trees	Closed needle-leaved	Open needle-leaved	Urban areas	Urban areas mixed	Waterbody artificial	Wadi	Waterbody natural	Waterbody	Water ponds	**USER'S ACCURACY** (%)
Basaltic plain	46	2						1									1									1				**90**
Bare		136	3			1	3		4					3	1		1									1				**89**
Chert plain		2	44									1														4				**86**
Open to closed woody vegetation				26			6	1	7	1		2		4	3											1				**51**
Irrigated orchards		1			92			4	1	2										1				1						**90**
Extraction site		7				42						1														1				**82**
Grassland sparse to very open		1					33	1	5	4				4						1				2						**65**
Herbaceous crop irrigated		1			2		1	45	1																	1				**88**
Herbaceous rainfed crop (in plain + terraced)							8		86	8																				**84**
Herbaceous crop rainfed + orchard plantation							6		4	30				3					1	2				5						**59**
Industrial and/or other areas		10			1						39			1																**76**
Dry mudflat		5	1									42		1				1								1				**82**
Wet mudflat		2										5	44																	**86**
Sparse to very open woody vegetation		5		1			13							25												7				**49**
River					1				1					1	46										1	1					**90**
Salt evaporation ponds																51														**100**
Sandy areas		1	4											1			43									2				**84**
Saline soil		8	2														1	36								4				**71**
Closed trees (mixed leaf type)										3									39	9										**76**
Open trees (mixed leaf type)		2					1		1	5				2						40										**78**
Closed needle-leaved trees							2		1	1											41	5		1						**80**
Open needle-leaved trees							6	1	3	3					1					2	3	29		3						**57**
Urban areas		5					2																33	11						**65**
Urban areas mixed with small cultivated fields and orchards		1							3		1												2	44						**86**
Waterbody artificial							1	1																	47	1	1			**92**
Wadi and seasonal wetland		3	6		2		2		2			2	1													81			3	**79**
Waterbody natural											1				2										6		39		3	**76**
Waterbody natural saline																												51		**100**
Water ponds		4						1							1										3		1		41	**80**
PRODUCER'S ACCURACY (%)	**100**	**69**	**73**	**96**	**94**	**98**	**39**	**82**	**72**	**53**	**95**	**79**	**98**	**56**	**85**	**100**	**93**	**97**	**98**	**73**	**93**	**85**	**94**	**65**	**82**	**77**	**95**	**100**	**87**	**80** OVERALL ACCURACY

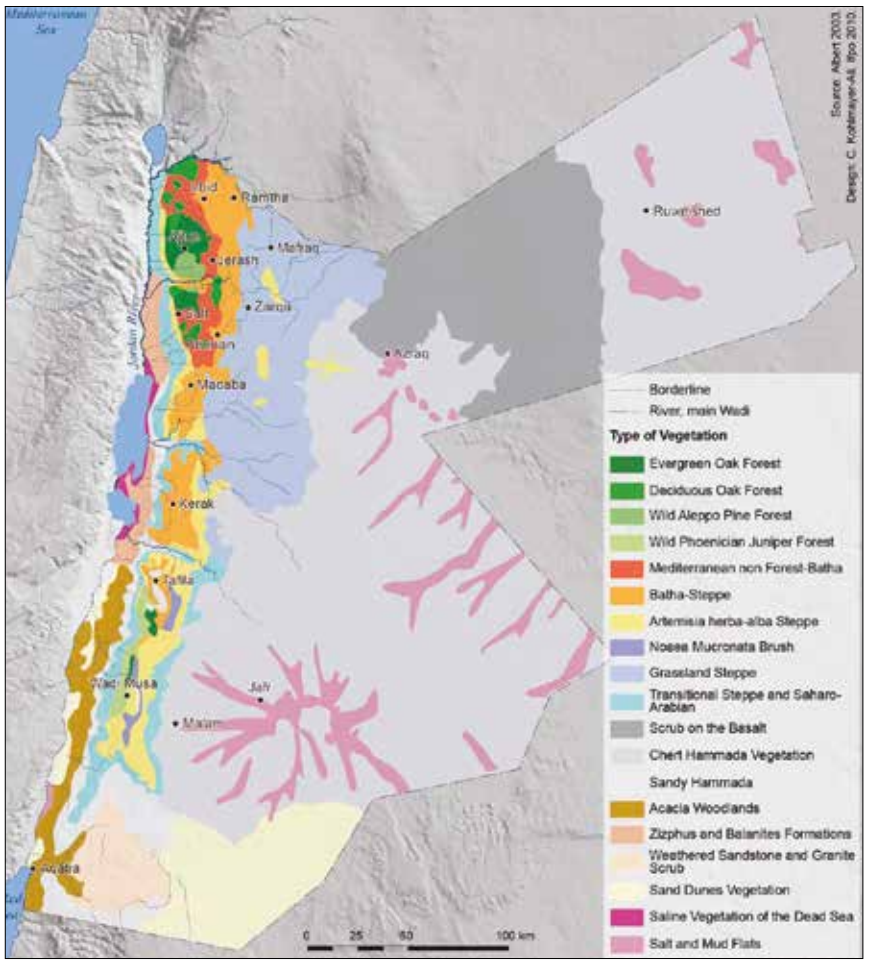


Figure 9. Vegetation types (source Albert 2003, design C. Kohlmayer-Ali IFPO 2010).

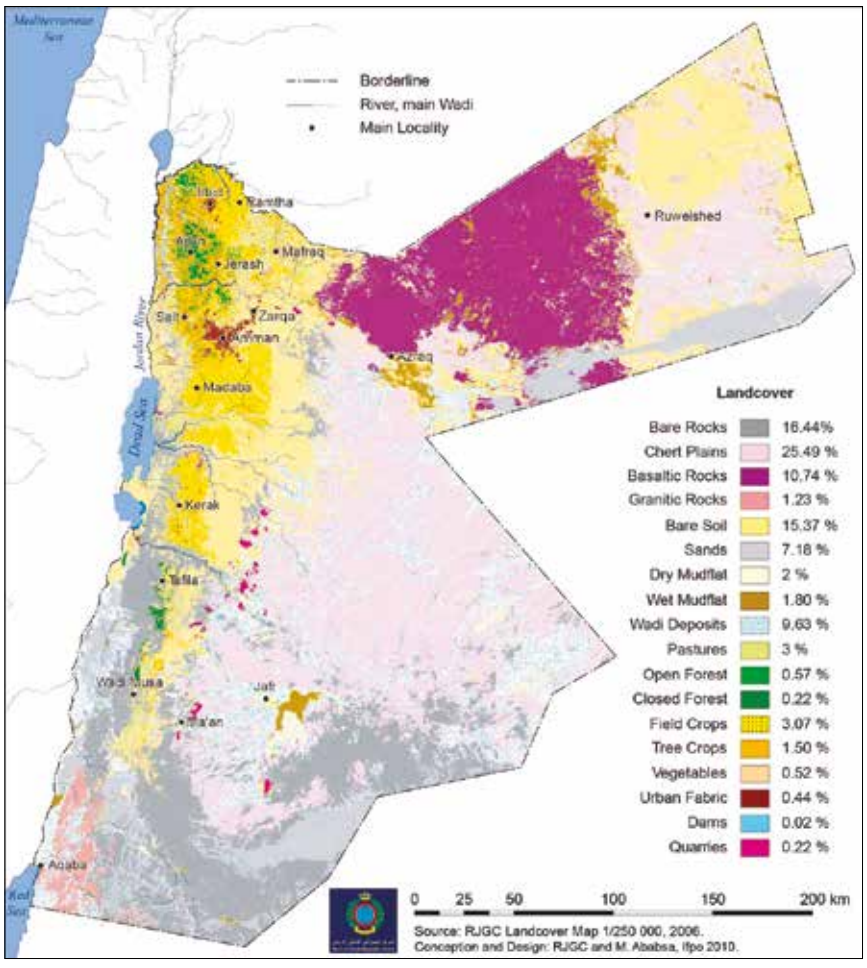


Figure 10. Landcover map (source RJGC 2006, conception and design RJGC and M. Ababsa, IFPO 2010)

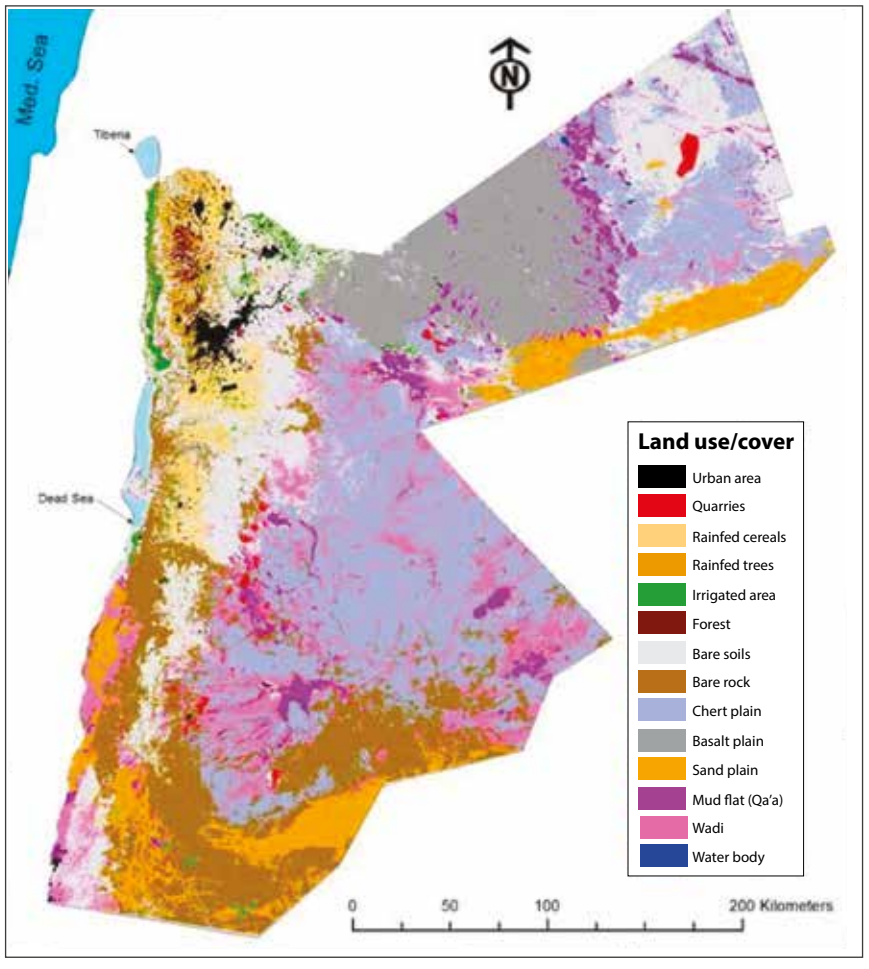


Figure 11. Land use/cover map (source Ababsa, 2013; Al-Bakri et al., 2013).

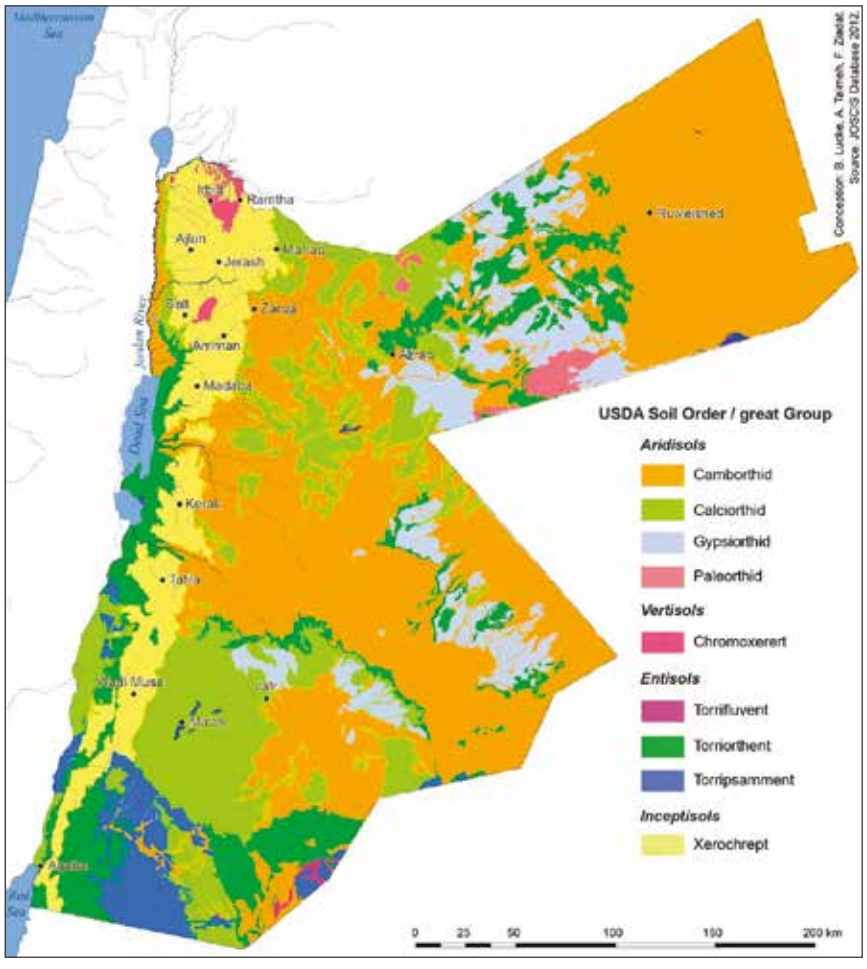


Figure 12. Main soil types (source Ababsa, 2013).

2.2.8 Ancillary datasets[12]

Land cover and soil

Prior to image interpretation, a review of existing land cover and soil datasets of the country was undertaken to provide an initial understanding of land characteristics and of the adopted classification systems.

In 2003, Albert et al. recognized 19 vegetation types based on previous studies undertaken in Jordan (e.g. Al-Eisawi, 1985 and 1996).

In 2006, the Royal Jordanian Geographic Centre released a series of land cover maps at a scale of 1: 250 000, interpreting Landsat 5 Satellite images at 30 m resolution. The 18 land cover categories follow the Corine land cover classification system developed by the European Environment Agency.

In 2013, in the framework of a study that investigated the impact of climate change and land use change on water resources and food security in Jordan, Al-Bakri et al., released the land use/land cover map of the country, derived from a combination of digital classification and visual interpretation of ASTER imagery at 15 m and Landsat Imagery at 30 m.

Soil maps of Jordan were produced by the National Soil Map and Land Use Project (NSM&LUP, 1993) which was carried out by the Ministry of Agriculture (MoA) and other institutions and agencies during the period 1989-1995. The soils at the reconnaissance level with a scale of 1:250 000 covered the entire country. In the framework of the development of the 'Atlas of Jordan, History, Territories and Society 2013', digital, nation-wide soil maps, strongly simplified, were derived from the soil database of the Jordan Soil and Climate Information System (JOSCIS) which was created during the NSM&LUP, 1993.

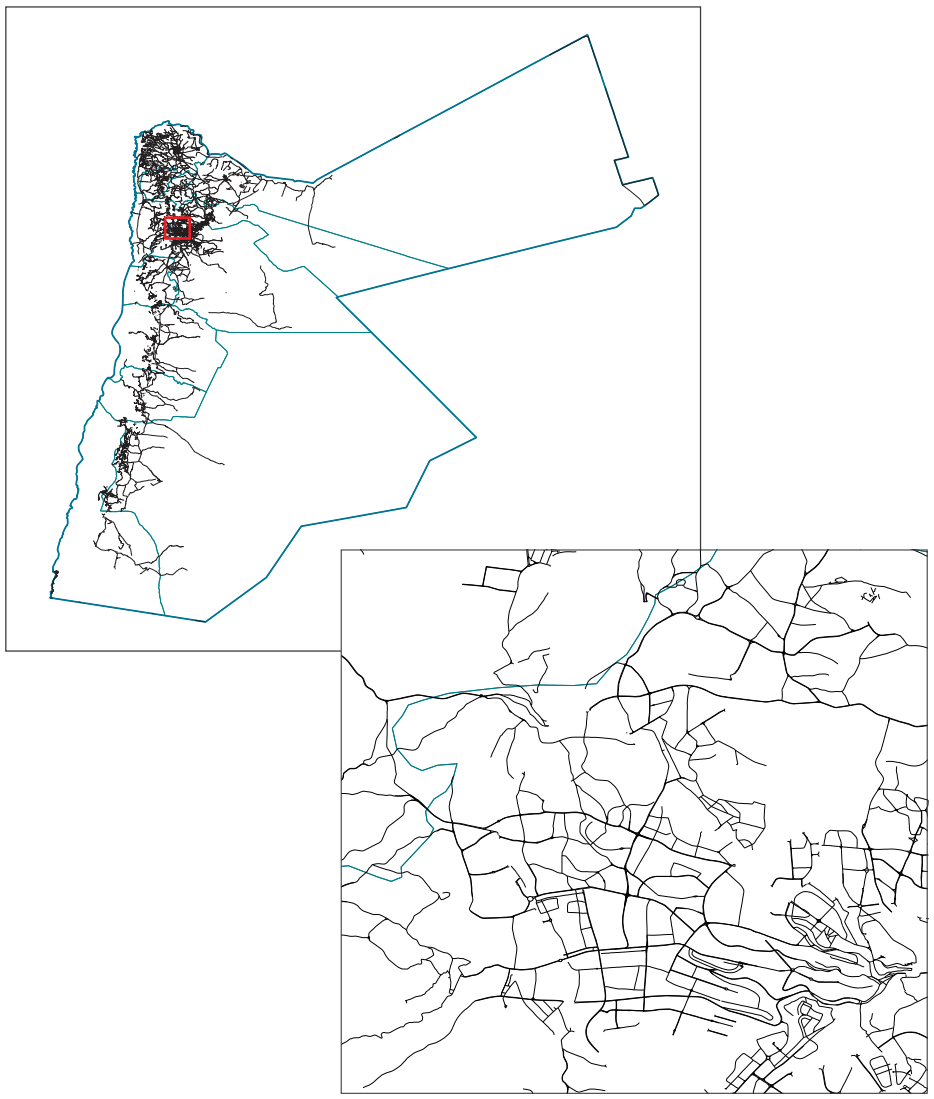


Figure 13. Roads network dataset in the 2016 LCDB.

Administrative dataset

The country is divided into twelve governorates (*muhafazah*). Governorates are further subdivided into 51 districts (*liwa*). Digital files of governorates and districts were provided by the RJGC and used for map layouts and reporting statistics on land cover.

Road network

The road network was obtained from available open data, mainly the OpenStreetMap (OSM) road dataset. Only primary and secondary roads were selected and clipped with the official Jordanian boundaries.

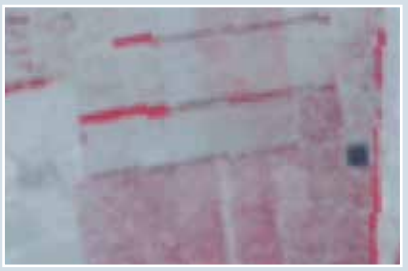
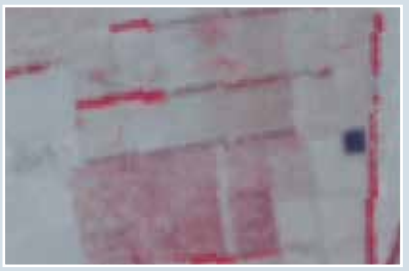
12 Albert, A., Petutschnnig, B. and Watzka, M. 2003. Zur Vegetation und Flora Jordaniens. In: Waitzbaur, W., Albert, R., Petutschnnig, B. and Aubrecht, G. (eds.): Reise Durch Die Natur Jordaniens. Biologiezentrum der Oberosterreichen Landesmuseen, J.-W-Klein-Str. 73, 4040 Linz, Austria.
Al-Eisawi, D.M. 1985. Vegetation of Jordan. In: Hadidi, A. (ed.): Studies in the History and Archaeology of Jordan. Vol I., p 45-56, Ministry of Archaeology and Tourism, Amman, Jordan.
Al-Eisawi, D.M. 1996. Vegetation of Jordan. UNESCO (ROSTAS), Cairo, Egypt, p 284.
Al-Bakri, Jawad T.; Duqqah, Mohmmad; Brewer, Tim R. 2013. Application of remote sensing and GIS for modeling and assessment of land use/cover change in Amman/Jordan http://dx.doi.org/10.4236/jgis.2013.55048

3 Land cover legend

Land Cover TYPE	Land Cover NAME	Cod	Land Cover DESCRIPTION
IRRIGATED ORCHARDS 2 classes	Fruit tree orchards (including vineyards)	IO	Fruit tree orchards mainly near water course (Jordan valley) and in the desert (Water pumped from ground water)
	Date palm plantation	DP	Regular date palm plantation
HERBACEOUS CROP IRRIGATED	Herbaceous crop irrigated	HCI	Irrigated Herbaceous crops minly near water course (Jordan valley) and in the desert (water pumped from ground water)
HERBACEOUS CROP RAINFED 2 classes	Herbaceous crop rainfed	HCR	Rainfed cultivation of herbaceous crop
	Terraced rainfed crop	TRC	Terraced rainfed crops in sloping land
RAINFED ORCHARDS	Herbaceous crop rainfed +orchard plantation	HCT	Rainfed cultivation of herbaceous crops + rainfed orchard plantation (olive)
CLOSED TREES 2 classes	Closed needle-leaved trees	TNL1	Closed needle-leaved trees (40% - 100%)
	Closed trees (mixed leaf type)	TM1	Closed trees undifferentiated (40% - 100%)
OPEN TREES 2 classes	Open needle-leaved trees	TNL2	Open needle-leaved trees (10%-40%)
	Open trees (mixed leaf type)	TM2	Open trees undifferentiated (10% - 40%)
WOODY VEGETATION 2 classes	Sparse to very open woody vegetation	OW	Open woody vegetation (5% - 40%) + Natural herbaceous vegetation
	Open to closed woody vegetation	CW	Closed woody vegetation (40% - 100%)
GRASSLAND	Grassland sparse to very open	GR	Herbaceous vegetation sparse to very open (5% - 40%)
BUILT-UP 3 classes	Urban areas	UA	Urban build-up areas
	Industrial and/or other areas	IA	Non urban build-up areas and other constructions (industrial, airport, etc.)
	Urban areas mixed with small cultivated fields and orchards	UAM	Urban build-up areas + small cultivated herbaceous crops + orchards and other plantation
SALINE SOIL	Saline soil	SS	Expanse of ground covered with salt
BARE SOIL	Bare soil	BS	Bare areas -undifferentiated areas not used for cultivation and usually devoid of grass or shrub cover, commonly associated with degraded land and erosion effects, sometimes within or adjacent to urban and rural areas
SANDY AREAS	Sandy areas	SD	Shifting and loosing sand not covered by vegetation and if present is negligible
UNDIFFERENTIATED BARE ROCK	Undifferentiated bare rock	BR	Rock outcrops
BARE ROCK GRANITE	Bare rock granite	BRG	Rock granite outcrops, commonly located in southern Jordan
CHERT PLAIN	Chert plain	CH	Flat expanse of ground covered with Chert stones and gravels commonly crossed by wadi
BASALTIC PLAIN	Basaltic plain	BAS	Flat expanse of ground covered with Basaltic stones and gravels
EXTRACTION SITE	Extraction site	EX	Major mines and quarries as well as temporary building material extraction
SALINE WATERBODY 2 classes	Waterbody natural saline	WNS	Saline water lake (Dead Sea)
	Salt evapotraspiration ponds	SA	Artificial ponds to extract salt from sea water
NATURAL WATERBODY AND FRESH WATER 2 classes	Waterbody natural	WNF	Natural fresh water lake
	River	RB	River Bank (bare soil) + Perennial or periodic flowing fresh water
ARTIFICIAL WATERBODY 2 classes	Waterbody artificial	WA	Artificial fresh water lake (dam reservoir)
	Water ponds	WP	Artificial fresh water, pool, ponds, small reservoirs
WETLANDS	Seasonal wetlands	WET	Seasonal fresh waterbody (2-8 weeks) + very open natural vegetation
WADI	Wadi	WAD	Bed of seasonal streams, usually dry, occasionally with very sparse woody vegetation (1-4%)
MUDFLAT 2 classes	Wet mudflat	MUDW	Area regularly flooded. Flooding persists 4-8 months
	Dry mudflat	MUDD	Mud deposits regularly flooded by stream. Flooding persists 1-2 months

Section 2

PHOTOKEYS

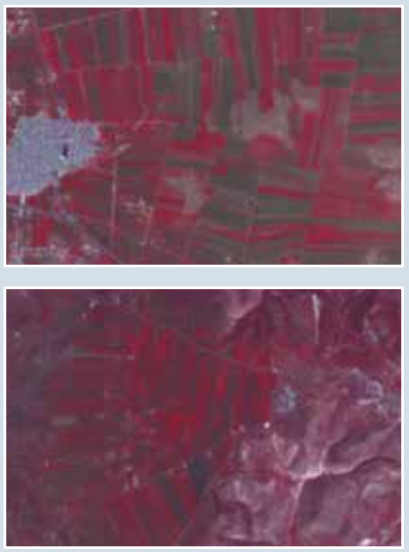
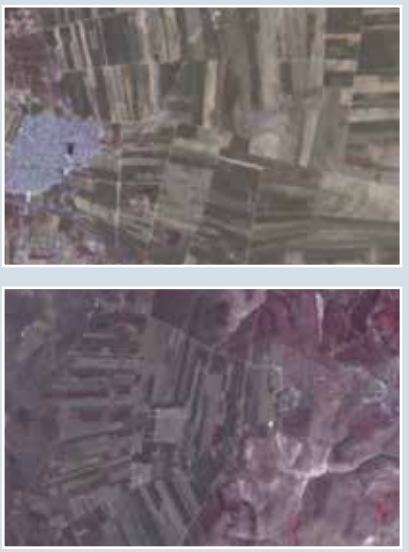
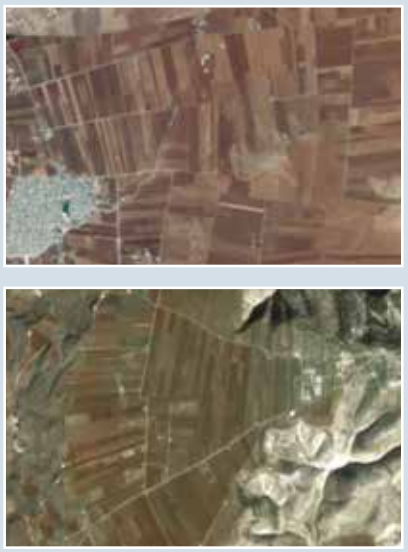
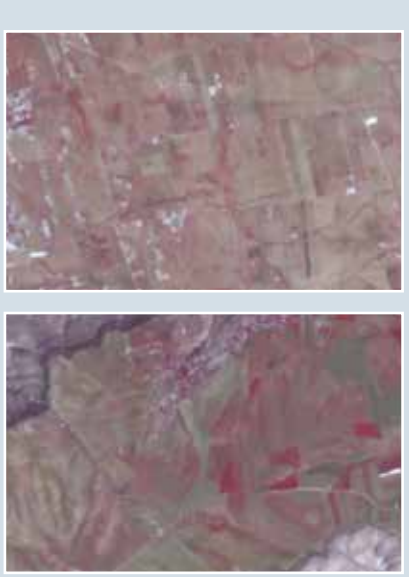
CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
IO	**FRUIT TREE ORCHARDS** Fruit tree orchards mainly near water course (Jordan valley)			
DP	**DATE PALM PLANTATION** Regular date palm plantation	 	 	 

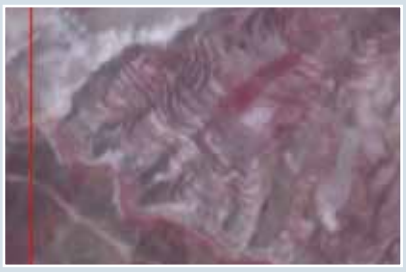
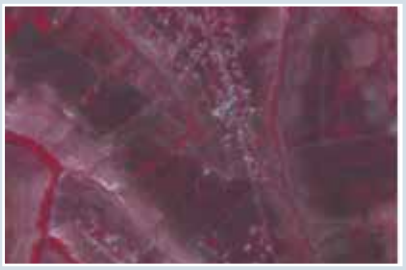
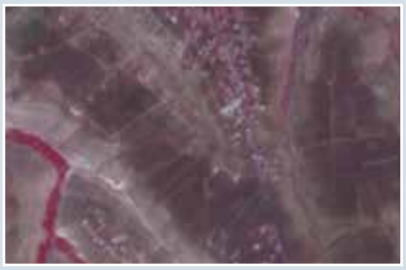
FRUIT TREE ORCHARDS
map code IO

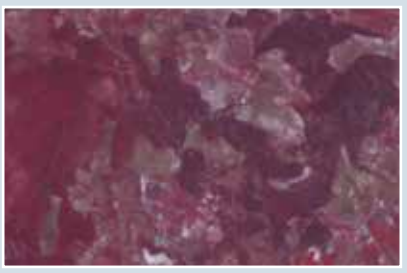
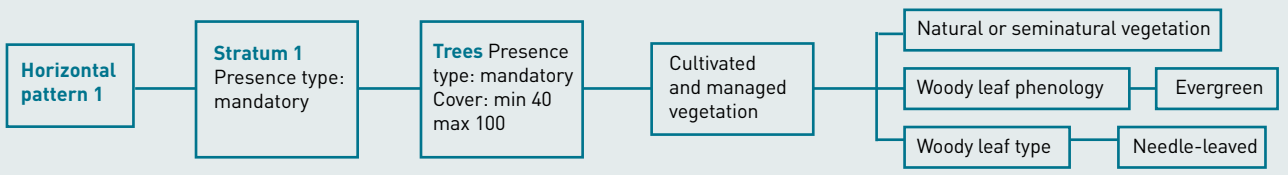
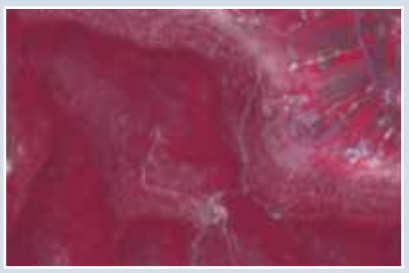
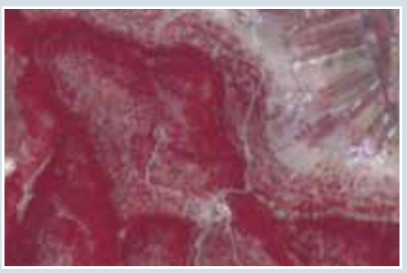
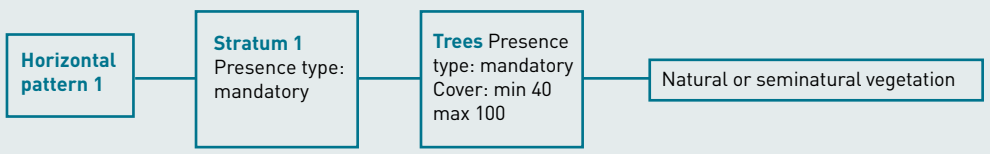
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Trees** Presence type: mandatory, cover min 60 max 80
      - Cultivated and managed vegetation
        - Irrigation
        - Orchard and other plantation

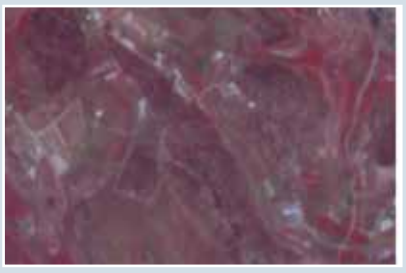
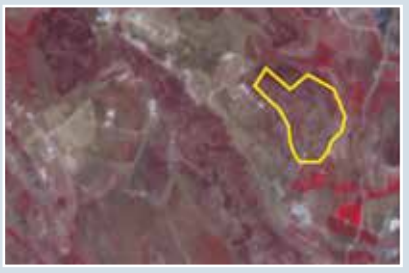
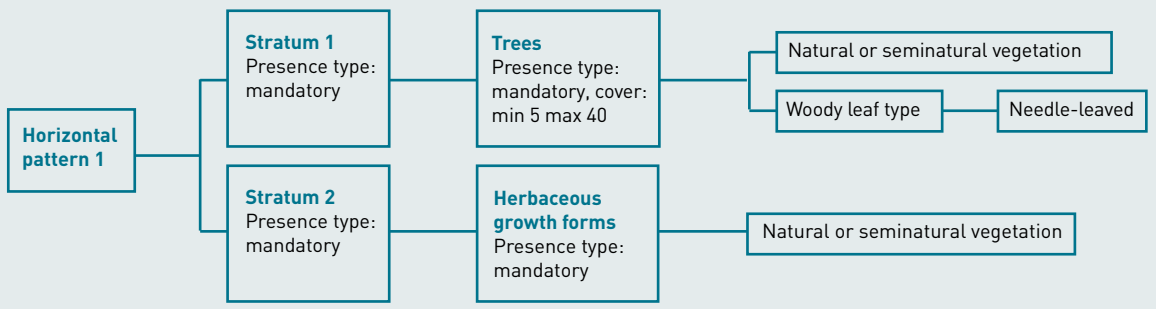
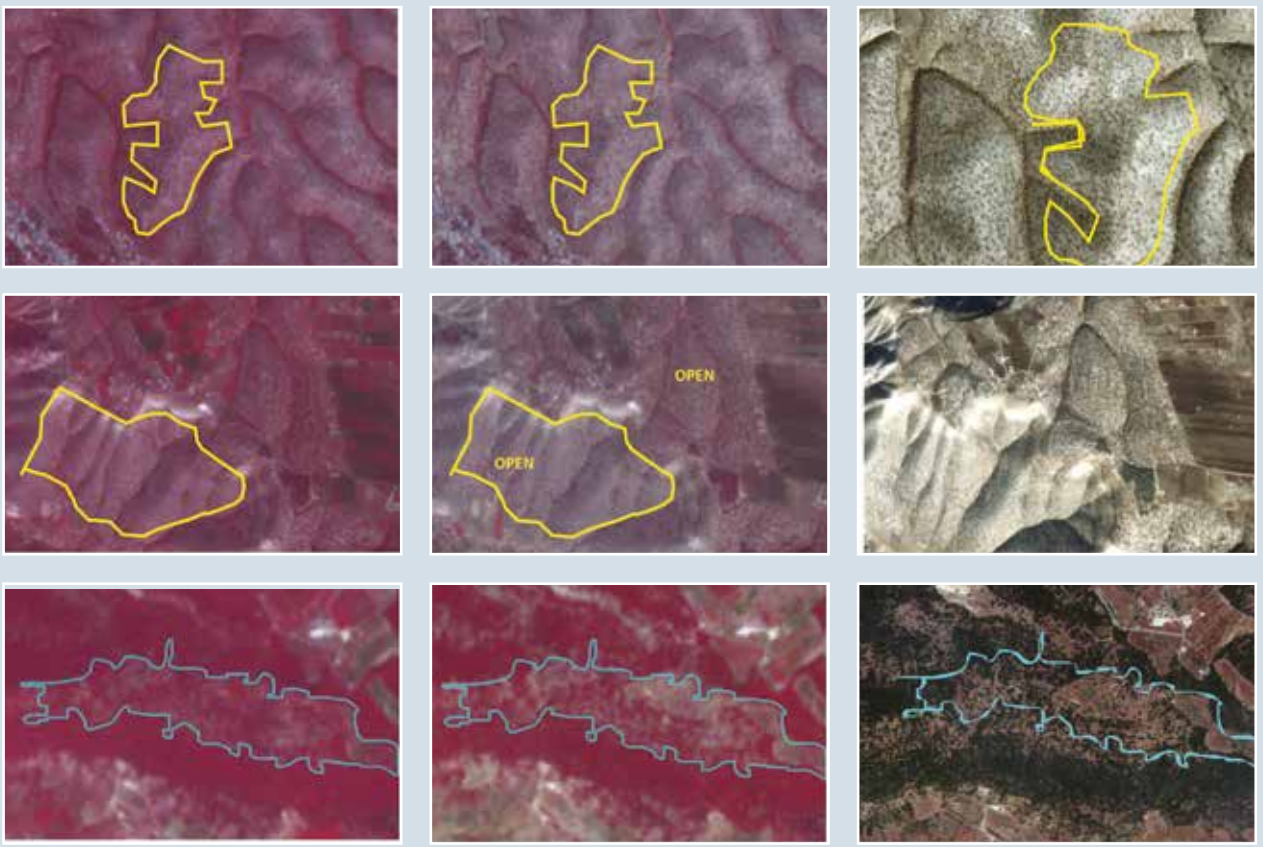
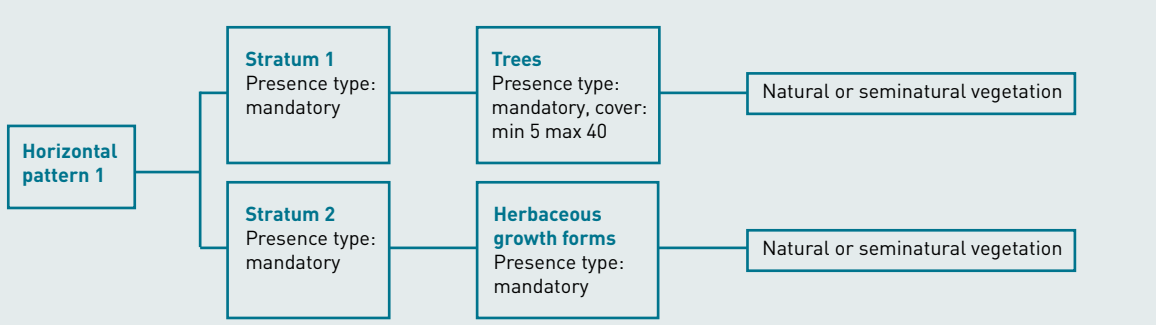
DATE PALM PLANTATION
map code DP

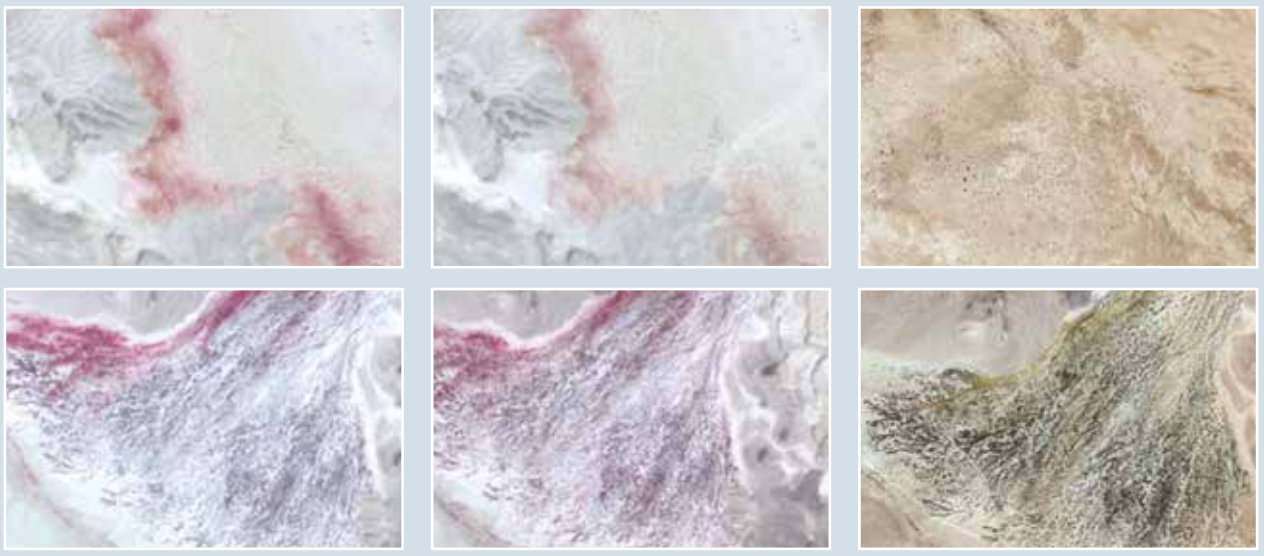
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Trees** Presence type: mandatory, cover min 60 max 80
      - Cultivated and managed vegetation
        - Irrigation
        - Orchard and other plantation
      - Floristic aspect
        - **Floristic aspect species** species name: Date palm

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
HCI	**HERBACEOUS CROP IRRIGATED** Irrigated herbaceous crops mainly near water course (Jordan Valley) and in the desert (water pumped from ground water)			
	IRRIGATED CROP map code HCI	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Herbaceous growth forms** Presence type: mandatory → Cultivated and managed vegetation → Irrigation		
HCR	**HERBACEOUS CROP RAINFED** Rainfed cultivation of herbaceous crop			
	RAINFED CROP map code HCR	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Herbaceous growth forms** Presence type: mandatory → Cultivated and managed vegetation → Rainfed		

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
TRC	**TERRACED RAINFED CROP** Terraced rainfed crops in sloping land			
	TERRACED RAINFED CROP map code TRC	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Herbaceous growth forms** Presence type: mandatory → Cultivated and managed vegetation → Rainfed; **Mechanical erosion control** type: terracing		
HCT	**RAINFED ORCHARDS** Rainfed cultivation of herbaceous crops + orchards plantation, usually olive trees	 	 	 
	RAINFED CROP map code HCT	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Herbaceous growth forms** Presence type: mandatory → Cultivated and managed vegetation → Rainfed; **Stratum 2** Presence type: optional → **Trees** Presence type: mandatory → Cultivated and managed vegetation → Rainfed; Floristic aspect → **Floristic aspect species** Species name: Olive			

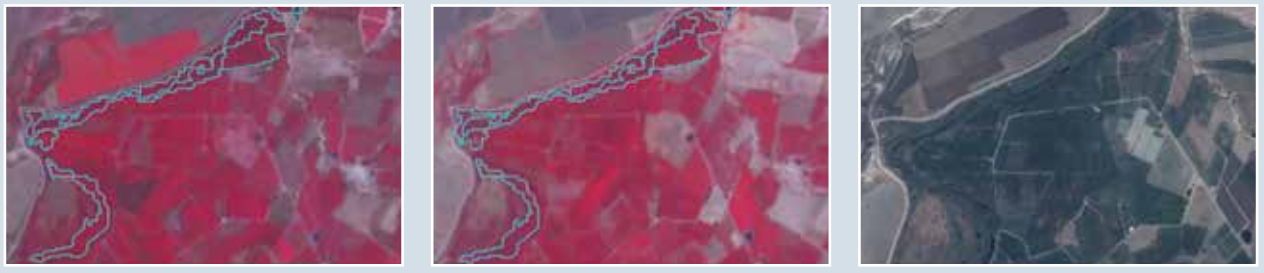
CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
TNL1	**CLOSED NEEDLE-LEAVED TREES** Closed needle-leaved trees 40% - 100%			
	TREES NEEDLE-LEAVED (CLOSED) map code TNL1			
TM1	**CLOSED TREES MIXED LEAF TYPE** Closed trees mixed (broadleaved, needle-leaved) 40% - 100%	 	 	 
	TREES MIXED (CLOSED) map code TM1			

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
TNL2	**OPEN NEEDLE-LEAVED TREES** Open needle-leaved trees 10% - 40%			
	TREES NEEDLE-LEAVED (OPEN) map code TNL2			
TM2	**OPEN TREES MIXED LEAF TYPE** Open trees mixed (broadleaved, needle-leaved) 10% - 40%			
	TREES MIXED (OPEN) map code TM2			

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
OW	**SPARSE TO VERY OPEN WOODY VEGETATION** Sparse to very open woody vegetation (5-40%) + Natural herbaceous vegetation			

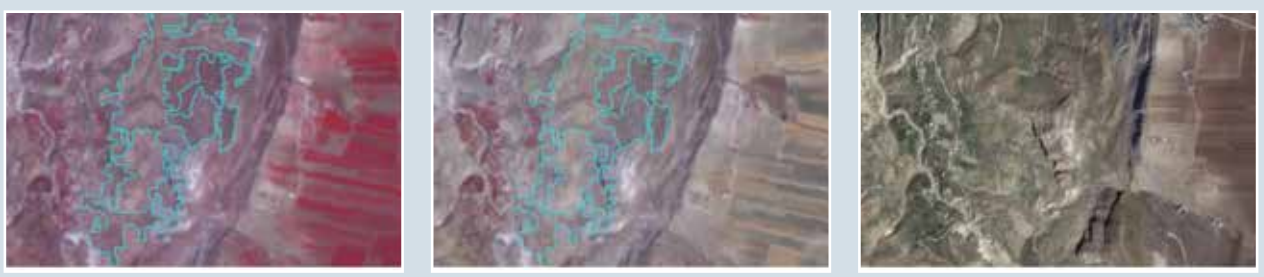
WOODY VEGETATION SPARSE TO VERY OPEN
map code OW

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Woody growth forms** Presence type: mandatory. Cover: min 5 max 40
      - Natural or seminatural vegetation
  - **Stratum 2** Presence type: mandatory
    - **Herbaceous growth forms** Presence type: mandatory
      - Natural or seminatural vegetation

CW	**OPEN TO CLOSED WOODY VEGETATION** Open to closed woody vegetation (40% - 100%)			

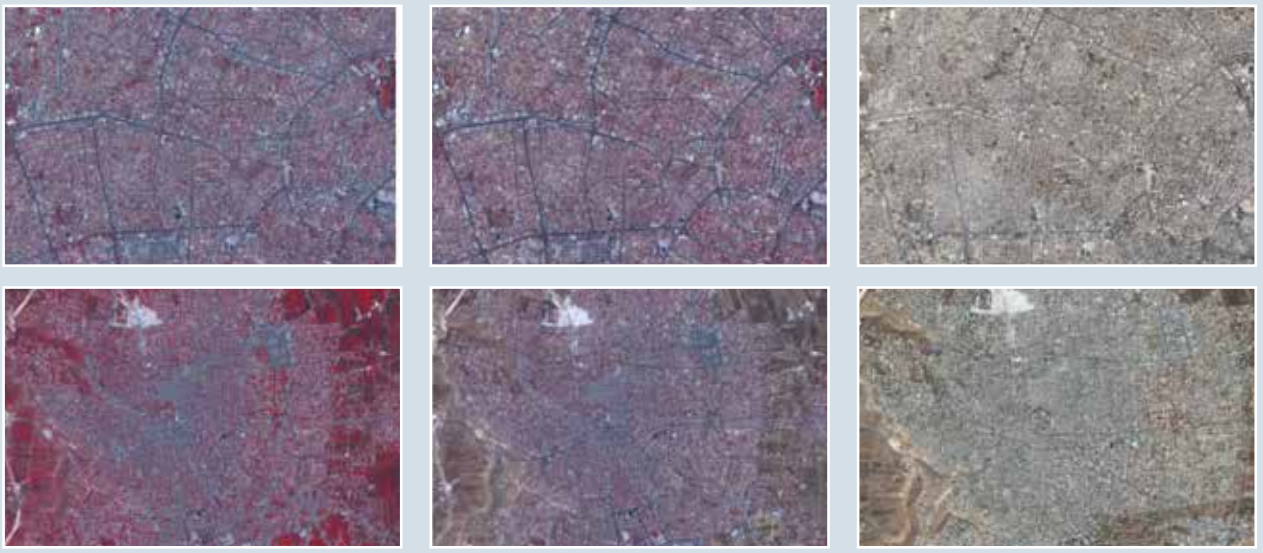
WOODY VEGETATION OPEN TO CLOSED
map code CW

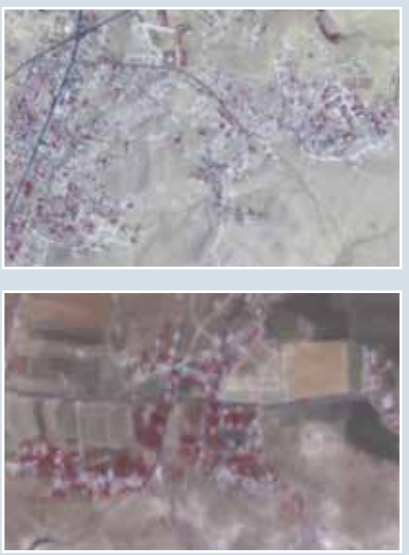
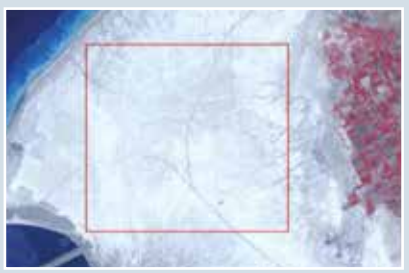
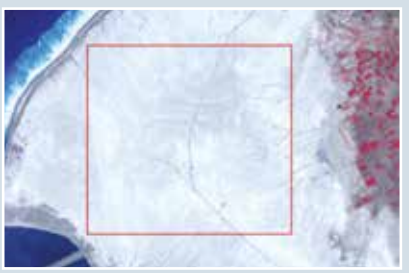
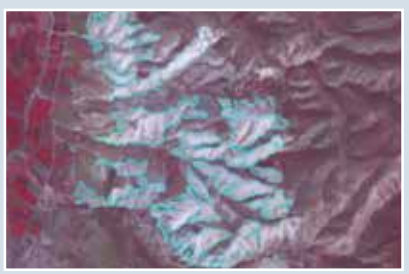
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Woody growth forms** Presence type: mandatory. Cover: min 40 max 100
      - Natural or seminatural vegetation
  - **Stratum 2** Presence type: mandatory
    - **Herbaceous growth forms** Presence type: mandatory
      - Natural or seminatural vegetation

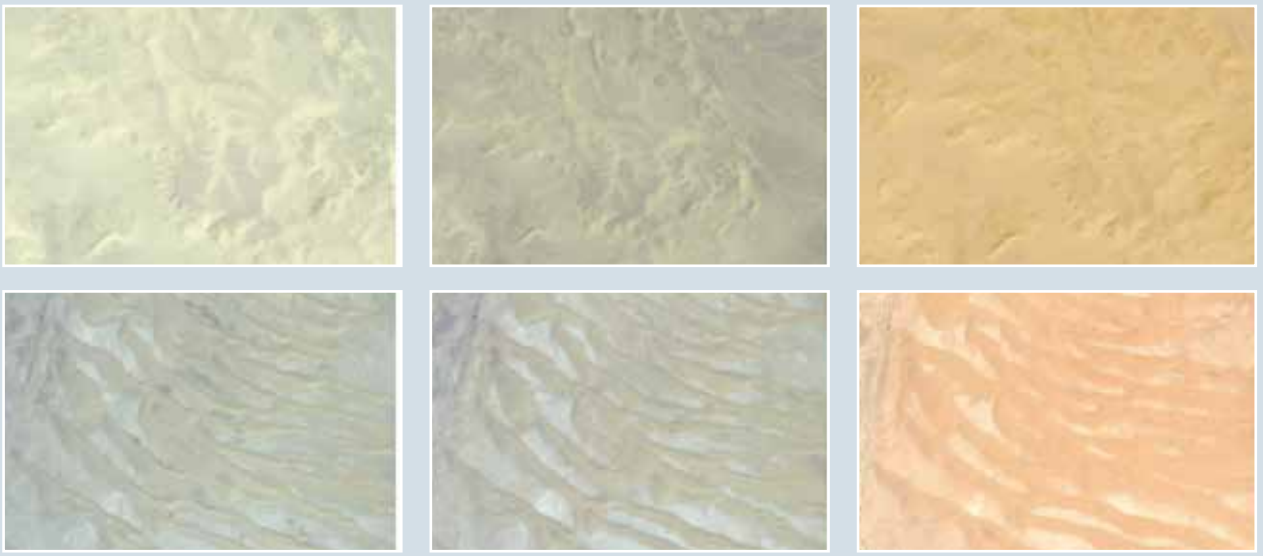
GR	**GRASSLAND** Herbaceous vegetation sparse to open (5% - 40%)			

GRASSLAND (SPARSE TO OPEN)
map code GR

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Herbaceous growth forms** Presence type: mandatory Cover: min 5 max 40
      - Natural or seminatural vegetation

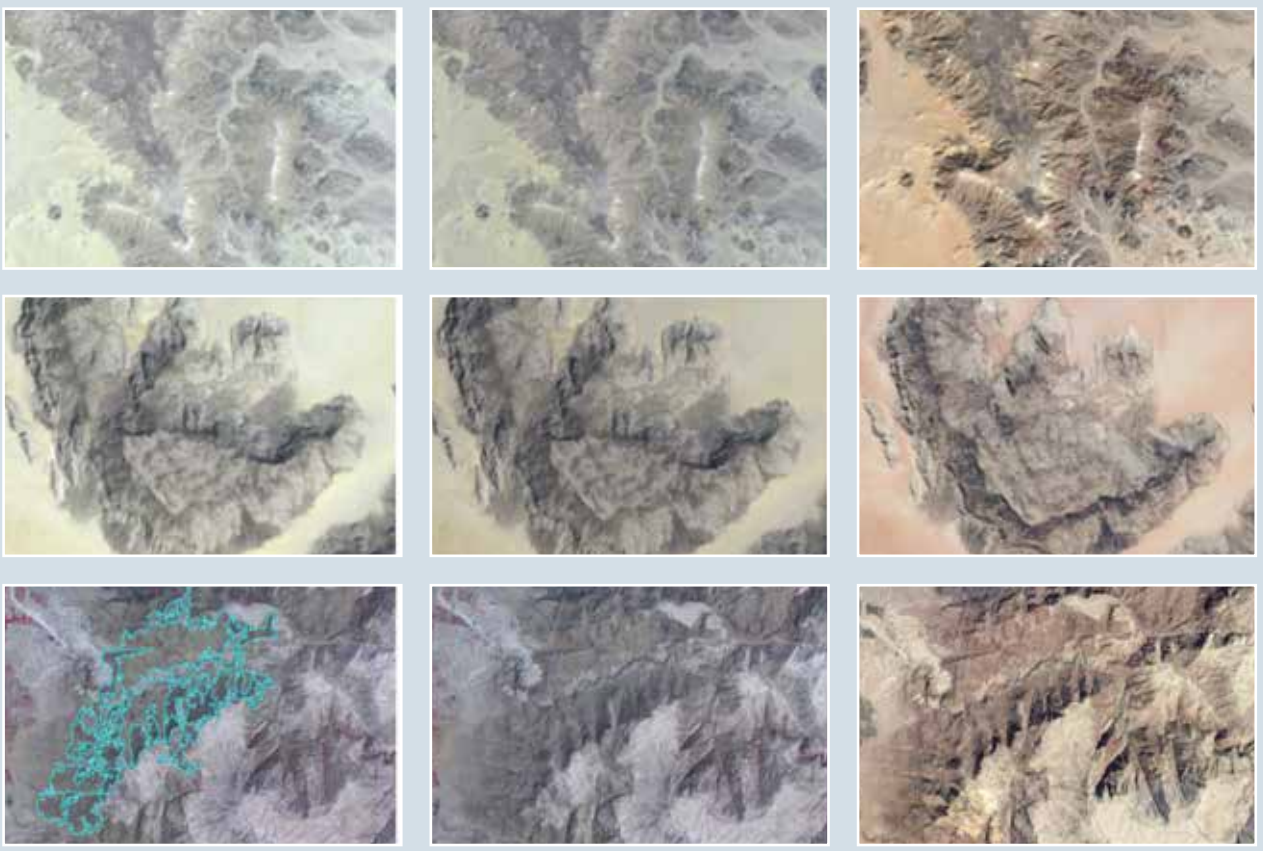
CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
UA	**URBAN AREAS** Urban built-up areas			
	URBAN AREA map code UA	**Horizontal pattern 1** — **Stratum 1** Presence type: mandatory — **Building** Presence type: mandatory		
IA	**INDUSTRIAL AND OTHER CONSTRUCTIONS** Non urban built-up areas and other constructions (industrial airport, etc.)			
	INDUSTRIAL AREAS map code IA	**Horizontal pattern 1** — **Stratum 1** Presence type: mandatory — **Other constructions** Presence type: mandatory		

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
UAM	**URBAN AREAS MIXED WITH SMALL CULTIVATED FIELDS AND ORCHARDS** Urban built-up areas + small cultivated herbaceous crops + orchards and other plantations			
	MIXED URBAN map code UAM	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Building** Presence type: mandatory **Horizontal pattern 2** → **Stratum 1** Presence type: mandatory → **Trees** Presence type: optional → Cultivated and managed vegetation → Orchards and other plantations **Horizontal pattern 3** → **Stratum 1** Presence type: mandatory → **Herbaceous growth forms** Presence type: optional → Cultivated and managed vegetation			
SS	**SALINE SOIL** Expanse of ground covered with salt			
	SALINE SOIL map code SS	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Inorganic deposit** Presence type: mandatory. Type: salt flat		
BS	**BARE SOIL** Bare areas - undifferentiated areas not used for cultivation, devoid of grass or shrub cover, associated with degraded land and erosion			
	BARE SOIL map code BS	**Horizontal pattern 1** → **Stratum 1** Presence type: mandatory → **Bare soil** Presence type: mandatory		

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
SD	**SANDY AREAS** Shifting and loosing sand not covered or with negligible vegetation			

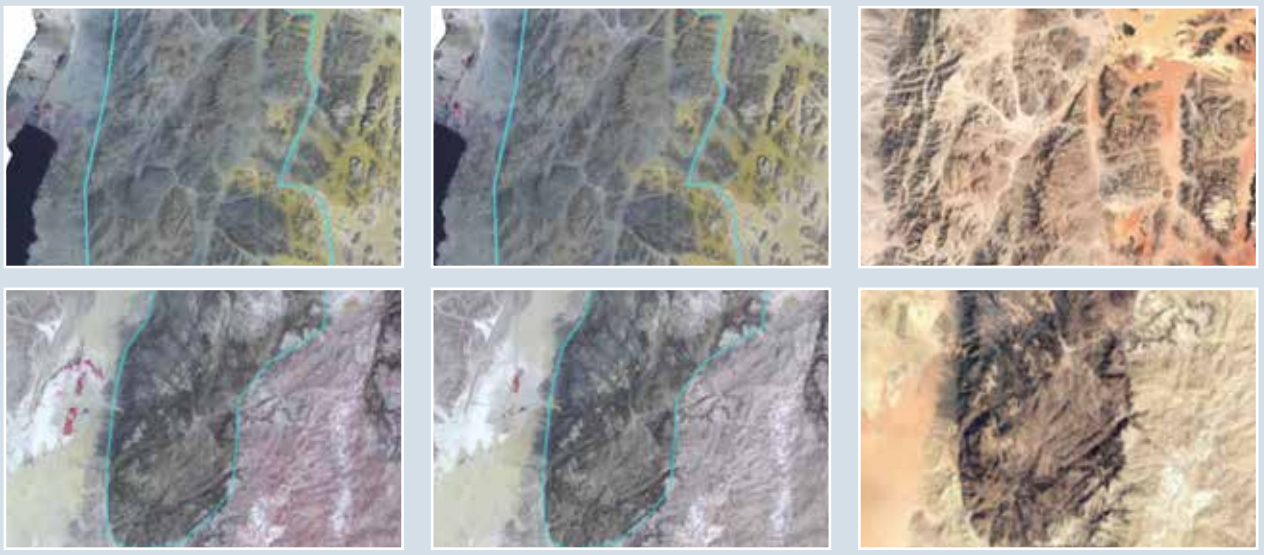
SANDY AREAS
map code SD

Horizontal pattern 1 — **Stratum 1** Presence type: mandatory — **Loose and shifting sand** Presence type: mandatory

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
BR	**UNDIFFERENTIATED BARE ROCK** Rock outcrops			

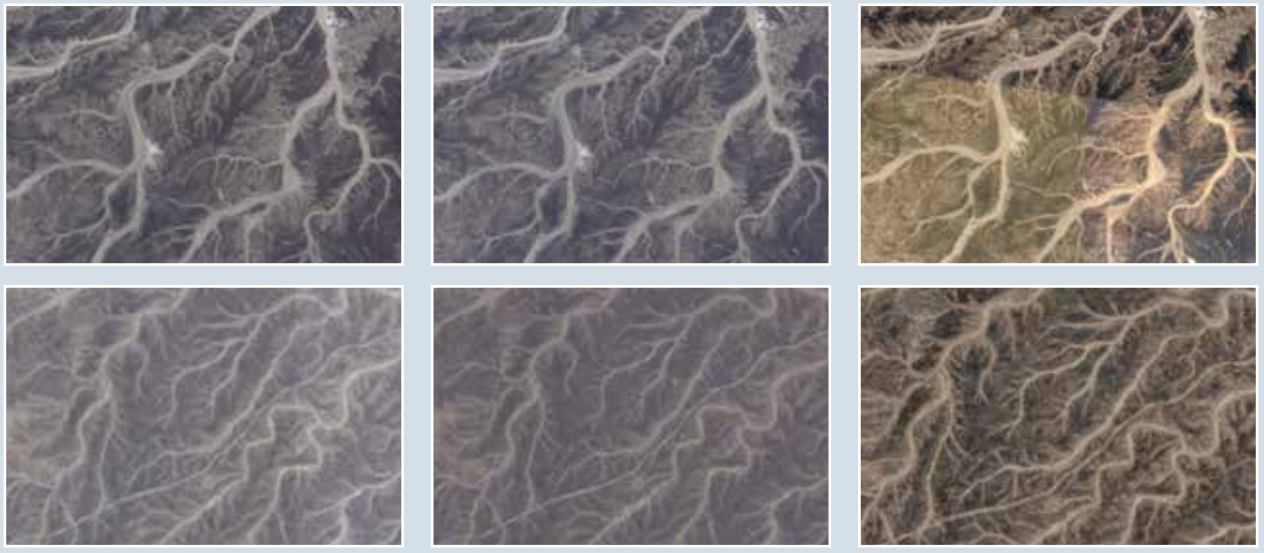
UNDIFFERENTIATED BARE ROCK
map code BR

Horizontal pattern 1 — **Stratum 1** Presence type: mandatory — **Bare rocks** Presence type: mandatory

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
BRG	**BARE ROCK: GRANITE** Rock granite outcrops			

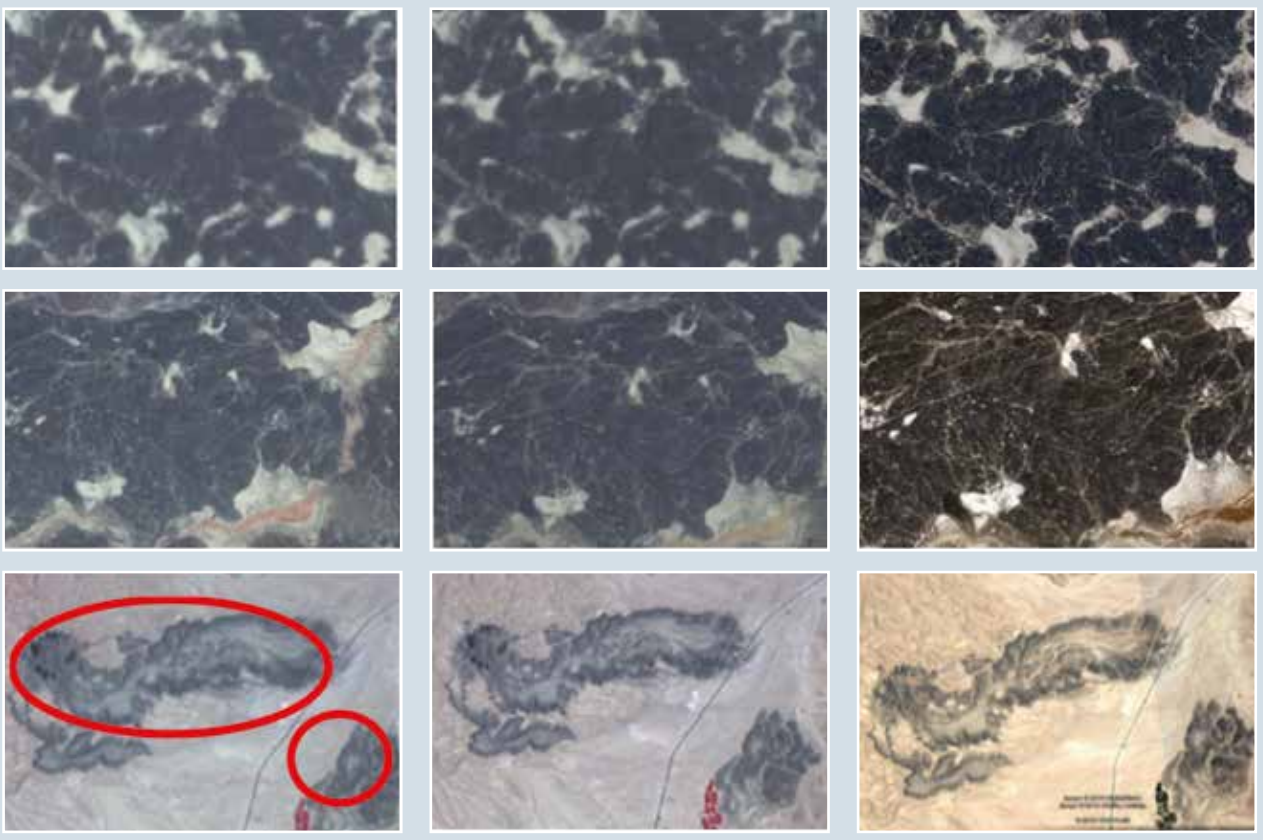
ROCK OUTCROP GRANITE
map code BRG

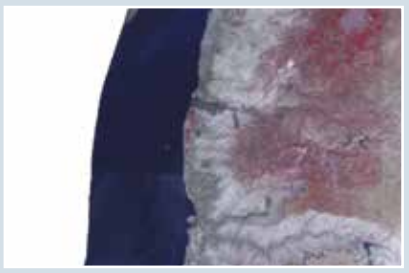
- **Consolidated surface characteristics** Rock type: granite
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Bare rocks** Presence type: mandatory

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
CH	**CHERT PLAIN** Flat expanse of ground covered with chert stones and gravel commonly crossed by wadi			

CHERT PLAIN
map code CH

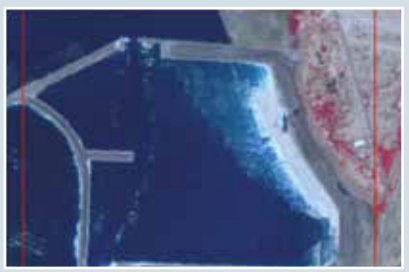
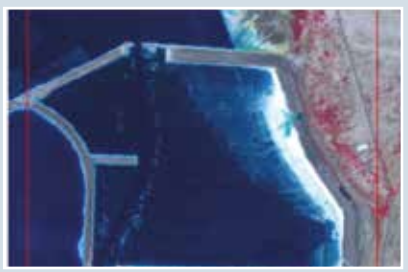
- **Consolidated surface characteristics** Rock type: chert
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Coarse mineral fragments** Presence type: mandatory. Type: gravel
    - **Coarse mineral fragments** Presence type: optional. Type: stone

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
BAS	**BASALTIC PLAIN** Flat expanse of ground covered with basaltic stones and gravel			
	BASALTIC PLAIN map code BAS	**Consolidated surface characteristics** Rock type: chert **Horizontal pattern 1** **Stratum 1** Presence type: mandatory **Coarse mineral fragments** Presence type: mandatory. Type: gravel **Coarse mineral fragments** Presence type: optional. Type: stone			
EX	**EXTRACTION SITE** Major mines and quarries as well as temporary building material extraction			
	EXTRACTION SITE map code EX	**Horizontal pattern 1** **Stratum 1** Presence type: mandatory **Extraction** Presence type: mandatory		

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
WNS	**WATERBODY NATURAL SALINE** Saline water lake (Dead Sea)			

WATERBODY NATURAL SALINE
map code WNS

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Waterbody** Presence type: mandatory; Dynamics: standing; Position: above surface
      - **Artificiality** type: natural
      - **Water salinity** type: saline

SA	**SALT EVAPORATION PONDS** Salt produced in salt ponds			

SALT EVAPORATION PONDS
map code SA

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Inorganic deposits** Presence type: mandatory. Type: salt flat
- **Horizontal pattern 2**
  - **Stratum 1** Presence type: mandatory
    - **Waterbody** Presence type: mandatory
      - **Artificiality** type: artificial
      - **Water salinity** type: saline

WNF	**WATERBODY NATURAL** Natural fresh waterbody lake			

WATERBODY NATURAL FRESH
map code WNF

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Waterbody** Presence type: mandatory; Dynamics: standing; Position: above surface
      - **Artificiality** type: natural
      - **Water salinity** type: fresh

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
RB	**RIVER BANK** (bare soil) + Perennial or periodic flowing fresh water			

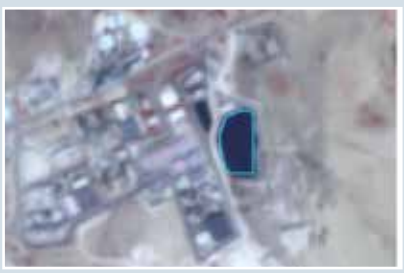
RIVER BANK
map code RB

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Bare soil** Presence type: mandatory
  - **Stratum 2** Presence type: mandatory
    - **Herbaceous growth forms** Presence type: mandatory. Cover: min 0 max 10
- **Horizontal pattern 2**
  - **Stratum 1** Presence type: mandatory
    - **Waterbody** Presence type: mandatory
      - **Artificiality** type: natural
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: months persistence period: min 1 max 12

WA	**WATERBODY ARTIFICIAL** Artificial fresh water lake (dam reservoir)			

WATERBODY ARTIFICIAL
map code WA

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Waterbody** Presence type: mandatory Dynamics: standing Position: above surface
      - **Artificiality** type: artificial
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: months persistence period: min 1 max 12

WP	**WATER PONDS** Artificial fresh water, pool, ponds, small reservoirs			

WATER PONDS
map code WP

- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Bare soil** Presence type: mandatory
  - **Stratum 2** Presence type: mandatory
    - **Herbaceous growth forms** Presence type: mandatory. Cover: min 0 max 10
- **Horizontal pattern 2**
  - **Stratum 1** Presence type: mandatory
    - **Waterbody** Presence type: mandatory Dynamics: standing Position: above surface
      - **Artificiality** type: artificial
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: months persistence period: min 1 max 12

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
WET	**SEASONAL WETLANDS** Seasonal fresh waterbody (2-8 weeks) + very open natural vegetation			

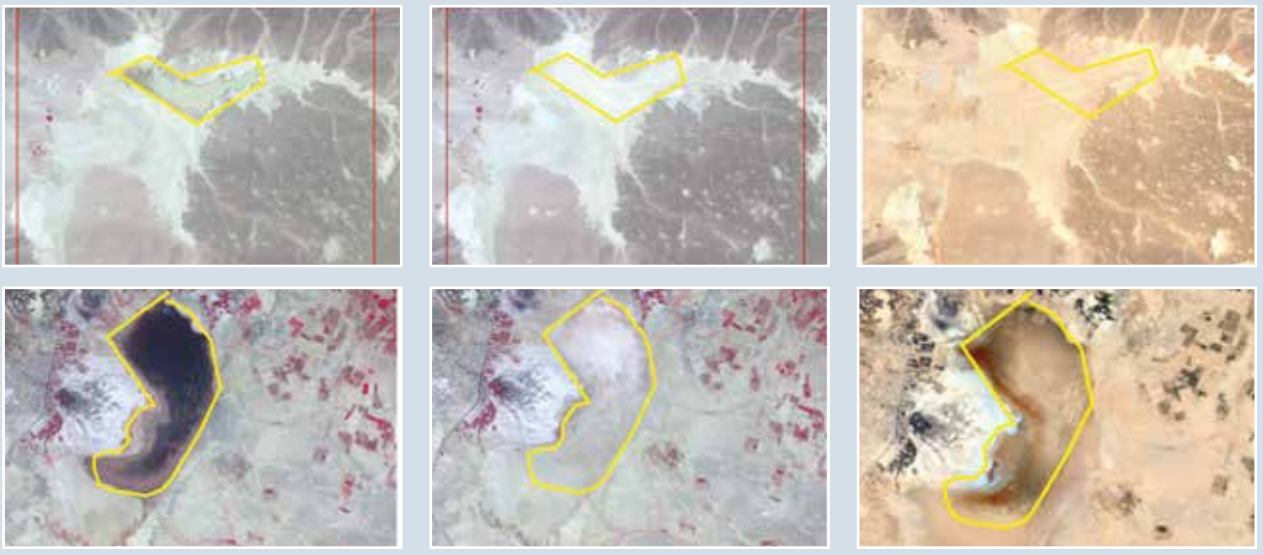
SEASONAL WETLANDS
map code WET

- **Geographical aspects** type: playa like surface
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Herbaceous growth forms** Presence type: mandatory. Cover: min 1 max 30
  - **Stratum 2** Presence type: mandatory
    - **Waterbody** Presence type: mandatory
      - **Artificiality** type: natural
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: weeks persistence period: min 2 max 8

WAD	**WADI** Bed of seasonal streams, usually dry, occasionally with very sparse woody vegetation (1-4%)			

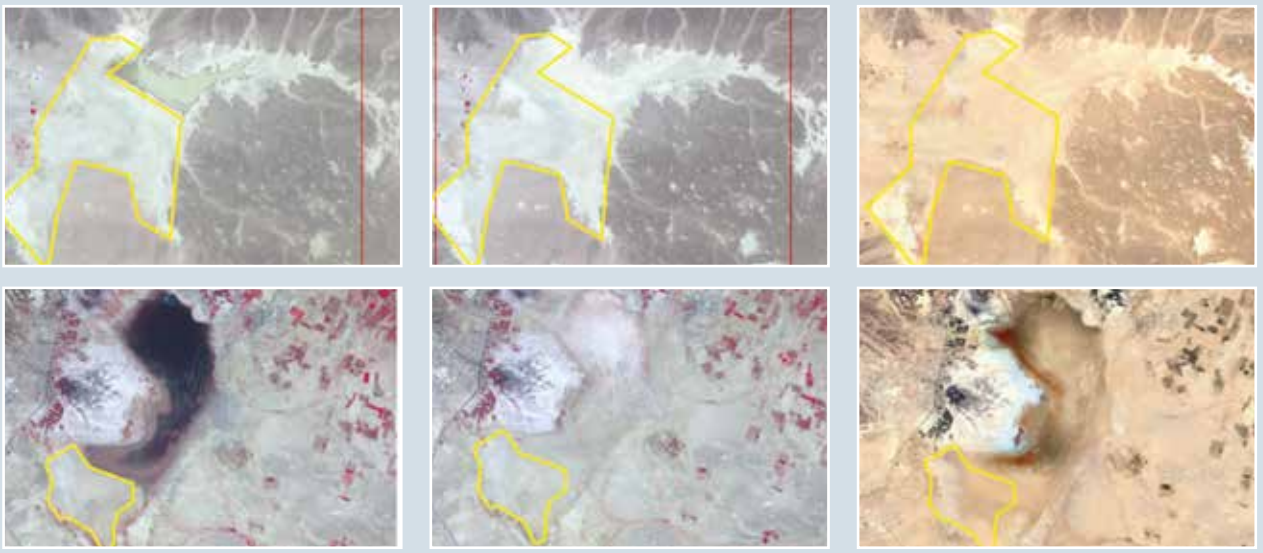
WADI
map code WAD

- **Geographical aspects** type: wadi
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Woody growth forms** Presence type: mandatory. Cover: min 1 max 10
      - Natural or seminatural vegetation
  - **Stratum 2** Presence type: mandatory
    - **Waterbody** Presence type: mandatory
      - **Artificiality** type: natural
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: weeks persistence period: min 1 max 2

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
MUDW	**WET MUDFLAT** (Playa like surface) Area regularly flooded. Flooding persists 4-8 months			

WET MUDFLAT
map code MUDW

- **Geographical aspects** type: playa like surface
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Bare soil** Presence type: mandatory
  - **Stratum 2** Presence type: mandatory
    - **Waterbody** Presence type: mandatory
      - **Artificiality** type: natural
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: months persistence period: min 4 max 8

CLASS CODE	CLASS NAME DESCRIPTION	SENTINEL 2 - FALSE COLOR (April 2016)	SENTINEL 2 - FALSE COLOR (August 2016)	GOOGLE EARTH
MUDD	**DRY MUDFLAT** (Playa like surface) Mud deposits regularly flooded by stream. Flooding persists 1-2 months			

DRY MUDFLAT
map code MUDD

- **Geographical aspects** type: playa like surface
- **Horizontal pattern 1**
  - **Stratum 1** Presence type: mandatory
    - **Bare soil** Presence type: mandatory
  - **Stratum 2** Presence type: mandatory
    - **Waterbody** Presence type: mandatory
      - **Artificiality** type: natural
      - **Water salinity** type: fresh
      - Periodic variations
        - **Periodic variations** persistence units: months persistence period: min 1 max 2

Section 3

LC MAPS

Symbols Legend

Legend for reading the land cover maps that will follow.

- National capital
- Provincial capital
- Town
- Main road
- International boundary
- Governorate boundary

Jordan

The Hashemite Kingdom of Jordan lies at the crossroads between Africa, Europe and Asia.

Its diverse landscapes reflect the variation of its climatic zones: the Mediterranean climate on the western mountains and the semi-arid and arid land in the eastern and northern regions.

The Jordan Statistical Yearbook, estimates that in 2017, Jordan had a population of 10 053 000 people, of which 90.3% were living in urban centres and 9.7% in rural areas.

Agriculture is concentrated in the Jordan River valley and on the northern and central uplands. According to the Jordanian Department of Statistics (DoS), the most planted field crops are barley, wheat, clover trefoil, chick-pea and maize, respectively. The most common fruit trees are olive, grape, citrus fruit, apple and peach.

Livestock plays an important role in Jordan's agriculture sector, the majority of both rural and nomad populations depend on it for their livelihoods. In 2015 the DoS reported that the country had 2 596 000 sheep, 860 000 goats and 73 000 cattle.

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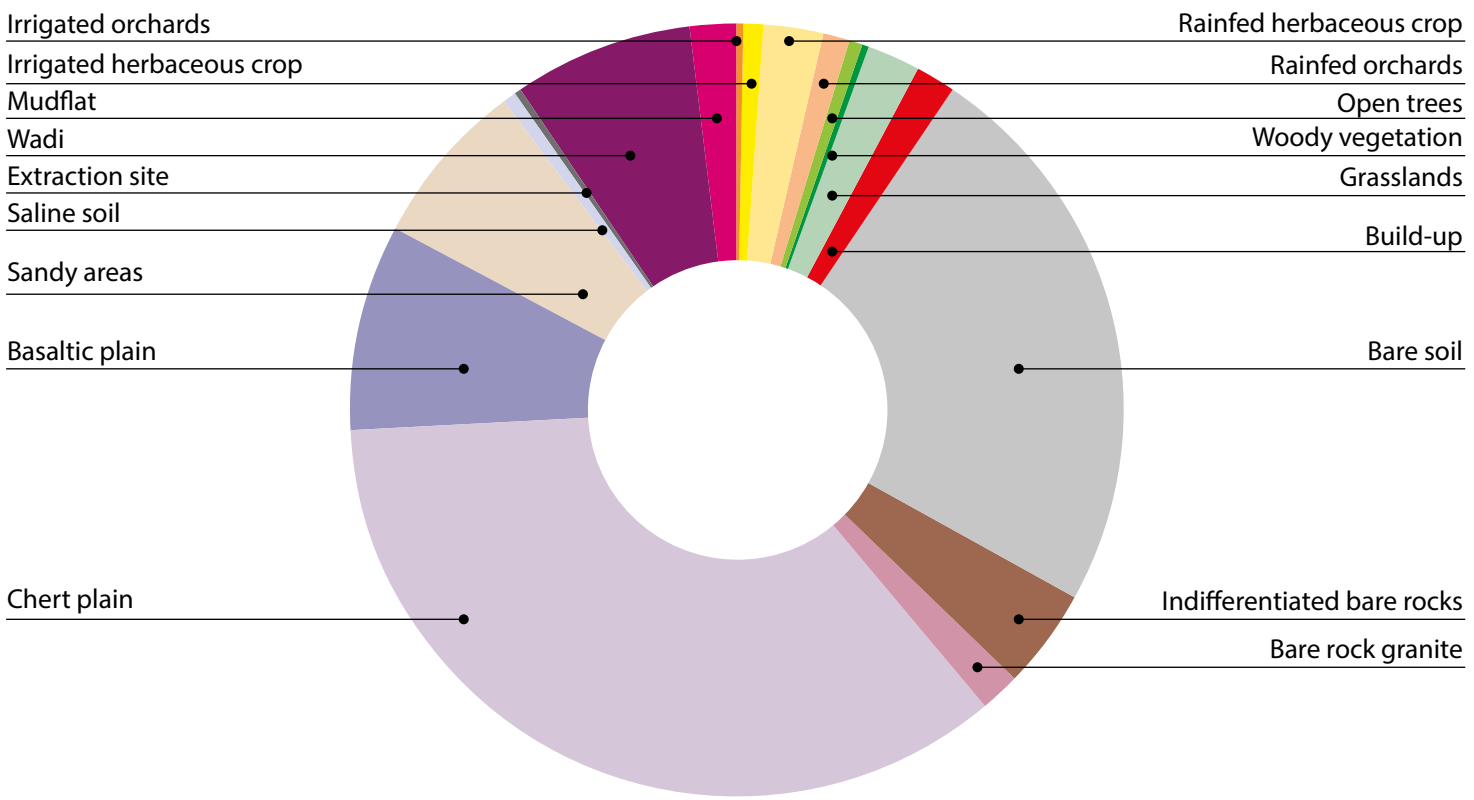
Jordan

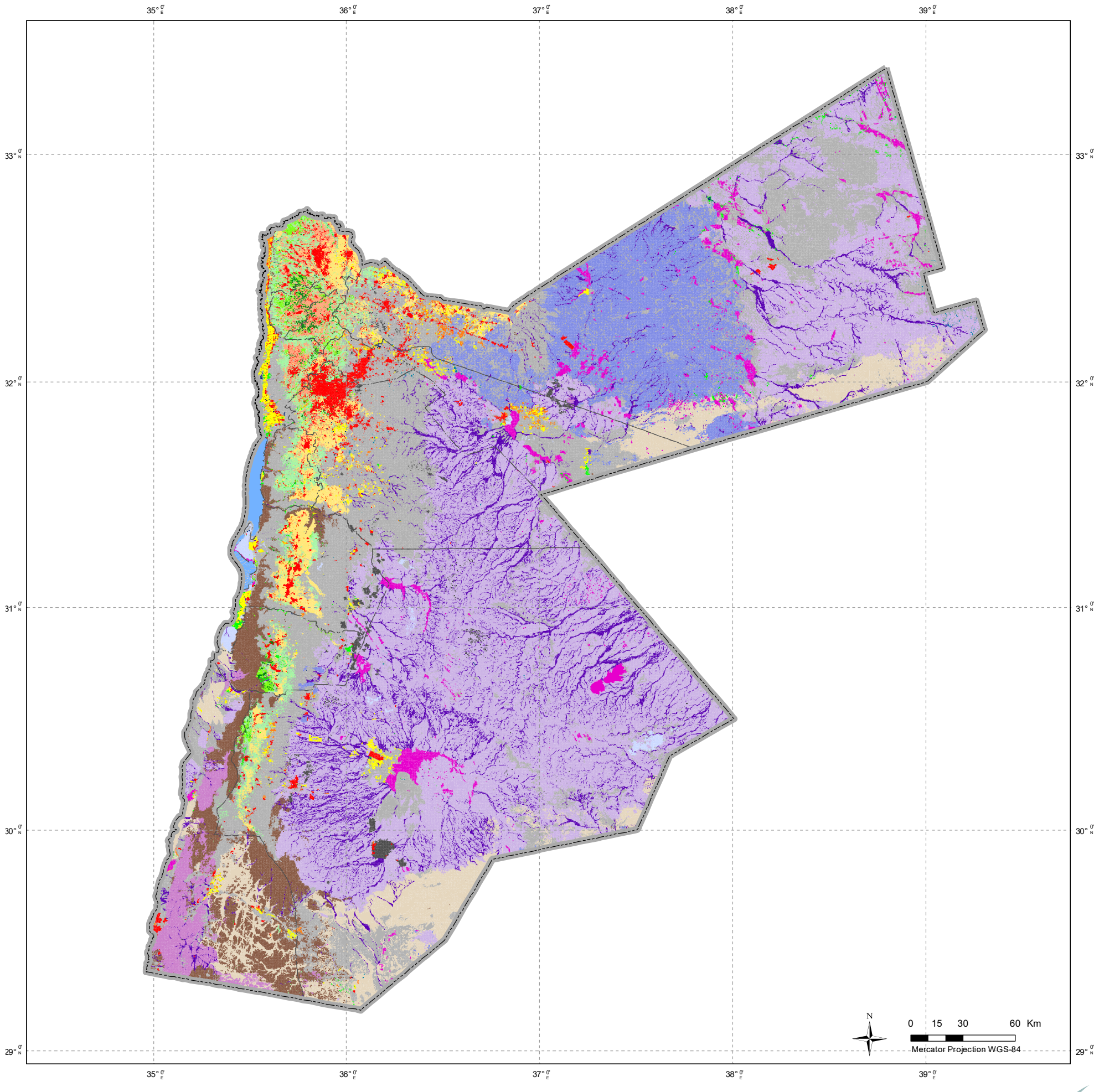


Aggregated land cover statistics of the Country by Governorates

LAND COVER CLASSES	GOVERNORATES												TOTAL km²	TOTAL %
	Ajloun	Amman	Aqaba	Balqa	Irbid	Jerash	Karak	Ma'an	Madaba	Mafraq	Tafilah	Zarqa		
Irrigated orchards	2.53	27.96	12.75	22.38	63	3.02	20.82	35.80	8.40	109.57	3.83	53.75	**363.82**	**0.41**
Irrigated herb. crop	2.77	57.66	40.61	174.26	70.90	1.80	74.45	103.52	7.59	98.46	2.60	87.96	**722.58**	**0.81**
Rainfed herb. crop	8.68	431.64	0.49	34.30	350.68	11.92	515.21	175.45	180.69	417.76	101.76	8.05	**2,236.62**	**2.52**
Rainfed orchards	123.92	97.93	0	134.05	281.56	161.70	1.95	0.53	28.31	48.75	2.37	36.79	**917.88**	**1.03**
Closed trees	50.70	10.30	0.97	14.06	25.97	38.14	3.75	9.38	1.39	2.91	21.85	1.50	**180.93**	**0.20**
Open trees	68.30	12	5.90	23.37	97.19	26.96	6.13	22.25	1.25	3.54	44.16	20.28	**331.34**	**0.37**
Woody vegetation	1.10	2.82	5.55	31.61	9.71	1.81	32.05	14.34	11.42	51.15	23.85	10.87	**196.27**	**0.22**
Grasslands	111.33	173.46	11.70	174.19	385.97	120.50	148.41	249.49	218.14	170.42	173.09	67.25	**2,003.95**	**2.26**
Build-up	25.40	423.72	69.23	84.79	206.85	31.64	115.74	103.30	35.07	203.55	38.55	163.52	**1,501.38**	**1.69**
Bare soil	19.97	3,360.85	1,192.80	401.56	53.59	10.16	1,634.08	4,203.66	330.62	7,114.78	853.59	1,825.53	**21,001.21**	**23.65**
Undiff. bare rocks	4.76	11.39	2,146.71	9.82	13.35	0	295.64	682.33	108.07	0.61	466.45	2.14	**3,741.26**	**4.21**
Bare rock granite	0	0	1,423.06	0	0	0	0	18.28	0	6.67	29.08	0.90	**1,477.99**	**1.66**
Chert plain	0	2,222.50	212.69	0	0	0	300.83	19,516.04	0	7,620.79	255.64	1,197.14	**31,325.62**	**35.28**
Basaltic plain	0	0.24	0	0	0	0	0	39.08	2.21	7,108.30	28.94	355.57	**7,534.35**	**8.49**
Sandy areas	0	0	1,466.05	2.40	0	0	5.43	2,675.20	0	1,666.84	52.23	351.19	**6,219.34**	**7.00**
Saline soil	0	0	0.03	0.52	0	0	169.71	155.80	0	0	2.50	11.62	**340.19**	**0.38**
Extraction site	0.80	30.98	1.06	3.57	2.53	0.76	70.44	217.69	0.96	37.88	39.95	28.52	**435.16**	**0.49**
Saline waterbody*	0	0	4.78	1.60	0	0	19.95	0	5.43	0	0	0	**31.77**	**0.04**
Natural waterbody	0	0.22	0.04	0.32	2.14	0.65	0.42	0.39	0	0.15	0	1.14	**5.47**	**0.01**
Artificial waterbody	0.01	2.33	0.73	6.87	2.32	1.28	2.98	2.57	0.79	5.87	1.35	4.08	**31.18**	**0.04**
Wetlands	0	6.03	0.09	0.41	0.21	0	0.15	2.45	0	16	0.02	5.53	**30.89**	**0.03**
Wadi	0	714.04	282.19	0.51	0	0.02	51.27	4,033.90	0.80	1,020.16	66.07	357.12	**6,526.07**	**7.35**
Mudflat	0	5.49	37.85	0	0	0	29.64	580.05	0	801.22	4.95	171.04	**1,630.25**	**1.84**
TOTAL LAND	**420.29**	**7,591.57**	**6,915.29**	**1,120.60**	**1,565.97**	**410.37**	**3,499.05**	**32,841.52**	**941.14**	**26,505.37**	**2,212.84**	**4,761.49**	**88,785.52**	**100**

* Statistical area is approximate due to raster resolution.

** Dead Sea is not included in these statistics.



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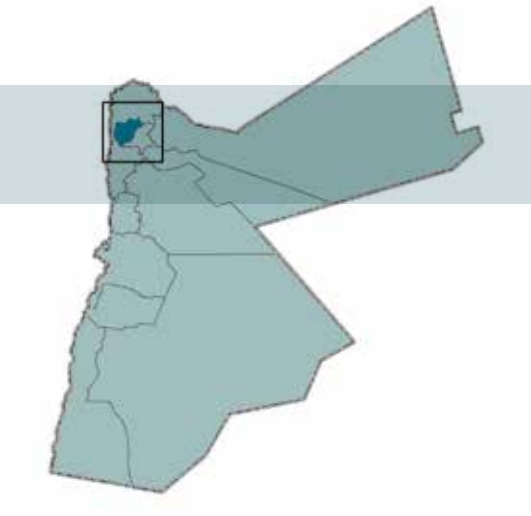


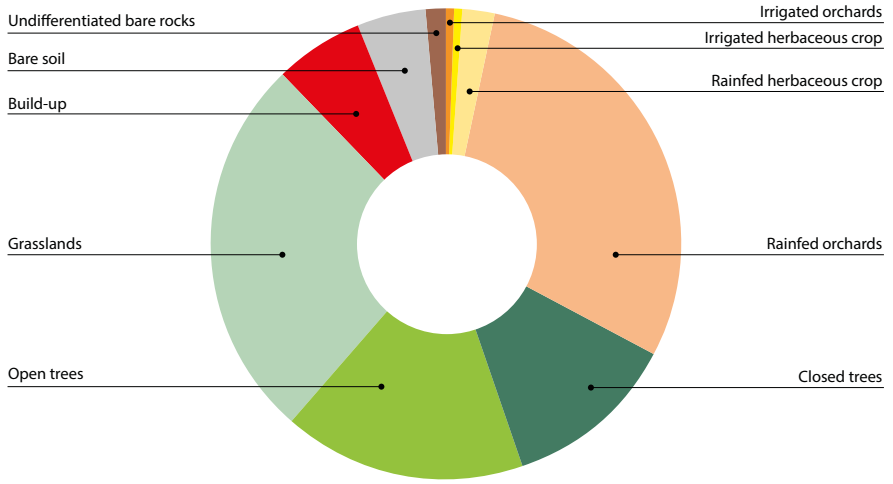
Ajloun

The Governorate of Ajloun is located at the northwestern corner of the Kingdom. It is one of the smallest Governorates of Jordan, with land characterized by agriculture, sparse forests and grassland.

The estimated population of the Governorate in 2017 was 185 700 (1.8% of Jordan), of which 83.9% were living in urban centres and the remaining 16.1% in rural areas.

Wheat, chickpea and barley are the most cultivated annual crops. Fruit trees are mainly olive, grape and apple.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2011, Ajloun had 1 627 cattle (2.2% of the national total), 50 704 goats (5.9%) and 30 190 sheep (1.2%).



Rainfall

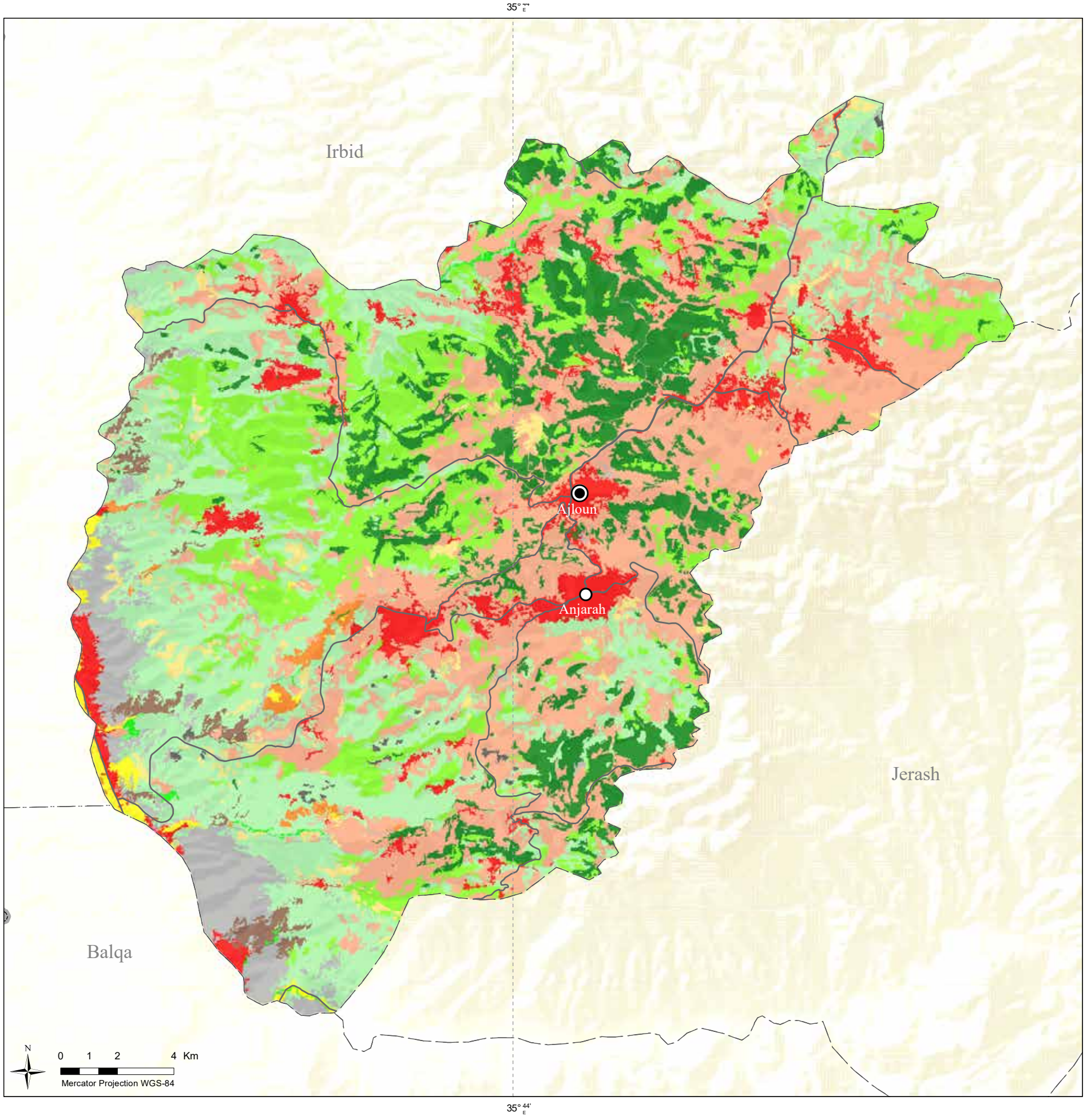
Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Ras Moneef	294.3	498.5	506	340.4	626.4	593.8

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Aljoun. ©Hiking in Jordan (CC BY-SA 2.0)

Aggregated land cover statistics of the Governorate by district

DISTRICTS					
LAND COVER CLASSES	**Kufranjah**	**Ajlun**	**TOTAL km²**	**TOTAL %**
Irrigated orchards	2.04	0.50	**2.53**	**0.6**
Irrigated herbaceous crop	2.04	0.73	**2.77**	**0.7**
Rainfed herbaceous crop	2.67	6.01	**8.68**	**2.1**
Rainfed orchards	18.15	105.77	**123.92**	**29.5**
Closed trees	0.53	50.17	**50.70**	**12.1**
Open trees	6.42	61.88	**68.30**	**16.3**
Woody vegetation	0.62	0.48	**1.10**	**0.3**
Grasslands	34.42	76.91	**111.33**	**26.5**
Build-up	5.57	19.84	**25.40**	**6.0**
Bare soil	11.25	8.72	**19.97**	**4.8**
Undifferentiated bare rocks	2.37	2.39	**4.76**	**1.1**
Bare rock granite	0	0	**0**	**0**
Chert plain	0	0	**0**	**0**
Basaltic plain	0	0	**0**	**0**
Sandy areas	0	0	**0**	**0**
Saline soil	0	0	**0**	**0**
Extraction site	0.51	0.29	**0.80**	**0.2**
Saline waterbody	0	0	**0**	**0**
Natural waterbody	0	0	**0**	**0**
Artificial waterbody	0.01	0	**0**	**0**
Wetlands	0	0	**0**	**0**
Wadi	0	0	**0**	**0**
Mudflat	0	0	**0**	**0**
TOTAL LAND	**86.59**	**333.70**	**420.29**	**100**



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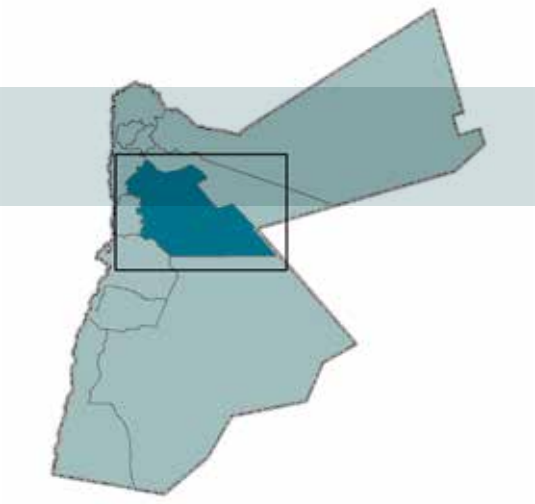
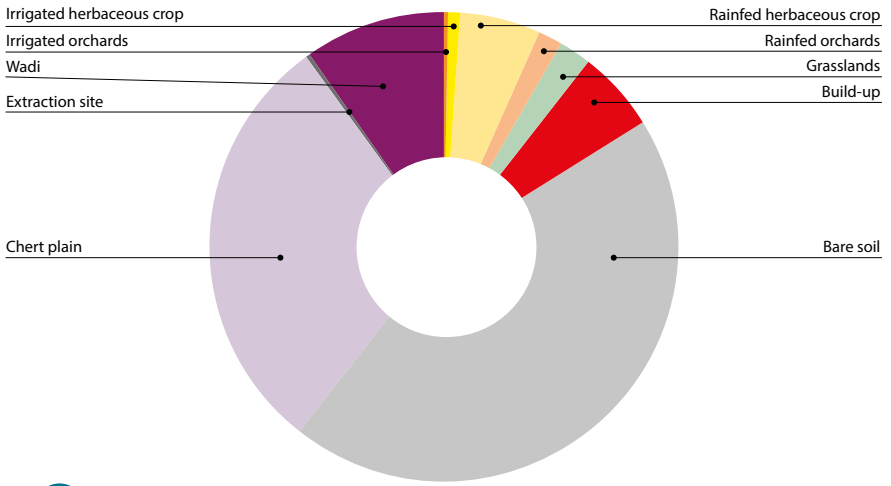


Amman



Amman Governorate, also referred to as the Capital Governorate, is one of the largest. It is the administrative, cultural and economic centre of the Kingdom, characterized by bare soils in the east and south and a diversity of landscapes in the western part. The capital city, Amman, is the most built up area of Jordan.

Estimated in 2017 as 4 226 700 (42% of Jordan), most of Jordan's population are concentrated in Amman. 97.2% living in urban centres and the remaining 2.8% in surrounding rural areas.Barley and wheat are the most cultivated annual crop. Most of the fruit trees are olive trees.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2011, Amman had 9 151 cattle (12.4% of the national total), 119 119 goats (13.8%) and 515 233 sheep (19.8%).

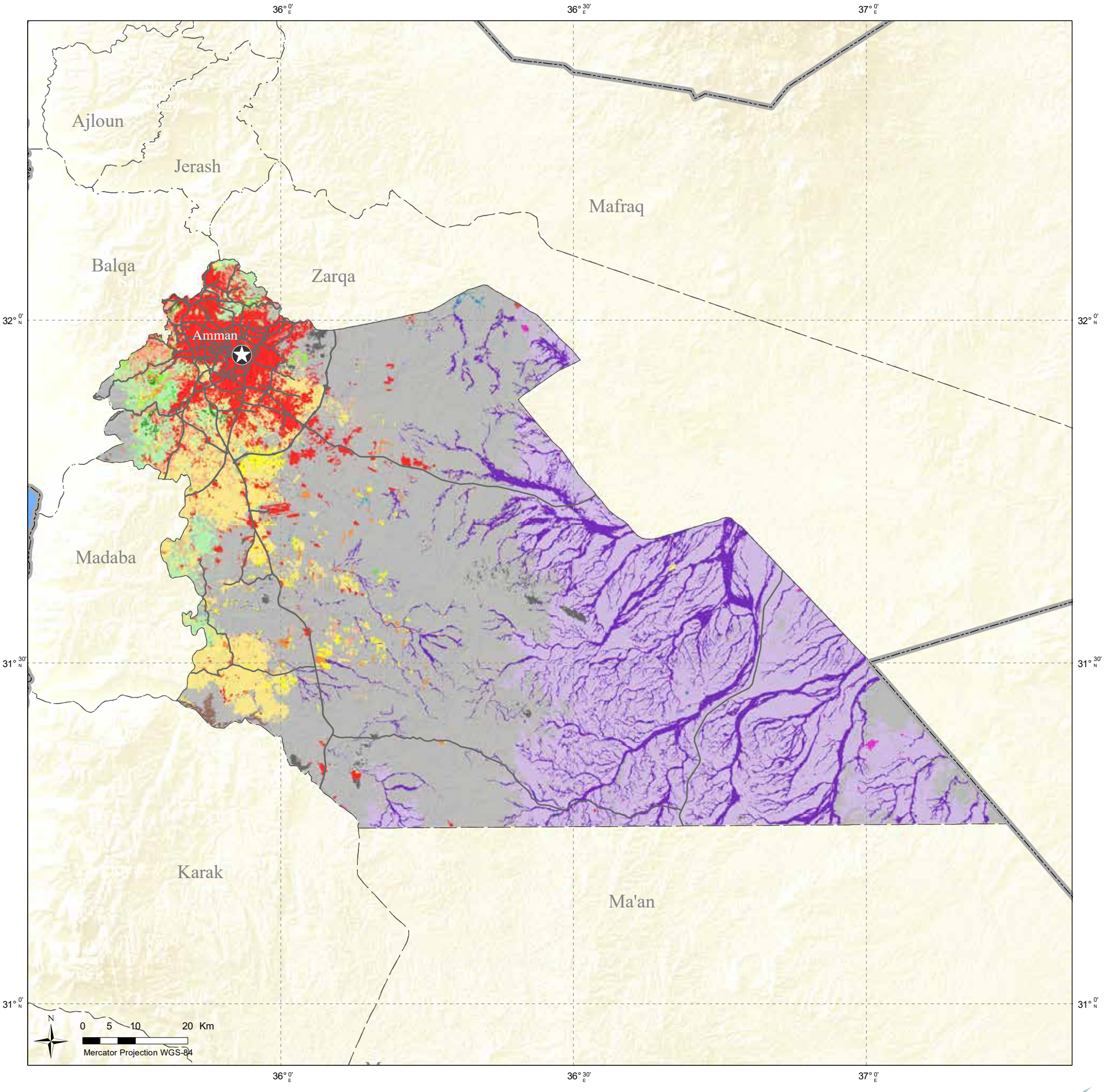
Rainfall

Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Amman Airport	119.3	246.4	275.6	197.4	241.8	266.2
Q.A.I. Airport	78.0	153.8	165.4	170.5	124.4	151.4

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS									TOTAL km²	TOTAL %
	Al-Jami'ah'	Al-Jizah	Al-Muaqqar	Al-Quaismah	Marka	Na'oor	Qasabet Amman	Sahab	Wadi Essier		
Irrigated orchards	0.01	19.09	4.36	0.44	0.34	0.60	0	0.9	3.04	**27.96**	**0.4**
Irrigated herbaceous crop	0	47.85	6.50	0.02	0.34	1.04	0	0.37	1.55	**57.66**	**0.8**
Rainfed herbaceous crop	3.94	308.05	16.17	29.40	4.48	42.55	0.18	20.66	6.20	**431.64**	**5.7**
Rainfed orchards	10.25	22.05	2.70	4.24	1.37	27.76	0.04	1.66	27.87	**97.93**	**1.3**
Closed trees	2.21	0.02	0	1.86	0.52	4.03	0.40	0	1.26	**10.30**	**0.1**
Open trees	0.86	0.32	0	0.40	2.53	1.20	0	0	6.69	**12**	**0.2**
Woody vegetation	0.29	0.54	0	0	0	0.43	0	0	1.56	**2.82**	**0**
Grasslands	25.36	48.63	0.27	6.39	4.55	45.58	1.14	0	41.53	**173.46**	**2.3**
Build-up	71.26	45.28	37.29	66.94	71.35	26.97	43.13	23.73	37.77	**423.72**	**5.6**
Bare soil	6.79	2,207.68	542.96	9.38	170.12	34.01	0.49	372.20	17.22	**3,360.85**	**44.3**
Undifferentiated bare rocks	0	10.90	0	0	0	0.49	0	0	0	**11.39**	**0.1**
Bare rock granite	0	0	0	0	0	0	0	0	0	**0**	**0**
Chert plain	0	2,103.98	88.90	0	0	0	0	29.61	0	**2,222.50**	**29.3**
Basaltic plain	0	0	0	0	0.13	0	0	0.11	0	**0.24**	**0**
Sandy areas	0	0	0	0	0	0	0	0	0	**0**	**0**
Saline soil	0	0	0	0	0	0	0	0	0	**0**	**0**
Extraction site	0	22.73	0.06	1.06	6.96	0	0	0.17	0	**30.98**	**0.4**
Saline waterbody	0	0	0	0	0	0	0	0	0	**0**	**0**
Natural waterbody	0	0.17	0.05	0	0	0	0	0	0	**0.22**	**0**
Artificial waterbody	0.01	2.01	0.06	0.11	0.01	0.03	0	0.03	0.09	**2.33**	**0**
Wetlands	0	2.19	1.43	0	0.01	0	0	2.40	0	**6.03**	**0.1**
Wadi	0	631.93	50.91	0	0	0	0	31.21	0	**714.04**	**9.4**
Mudflat	0	4.50	0	0	0	0	0	0.99	0	**5.49**	**0.1**
TOTAL LAND	**120.97**	**5,477.92**	**751.66**	**120.23**	**262.72**	**184.69**	**45.37**	**483.22**	**144.79**	**7,591.57**	**100**



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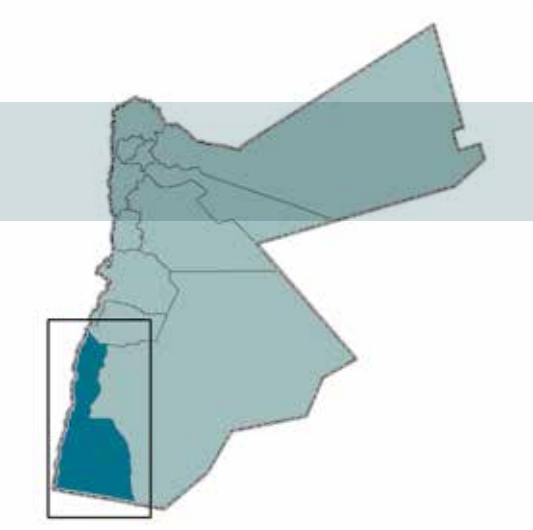


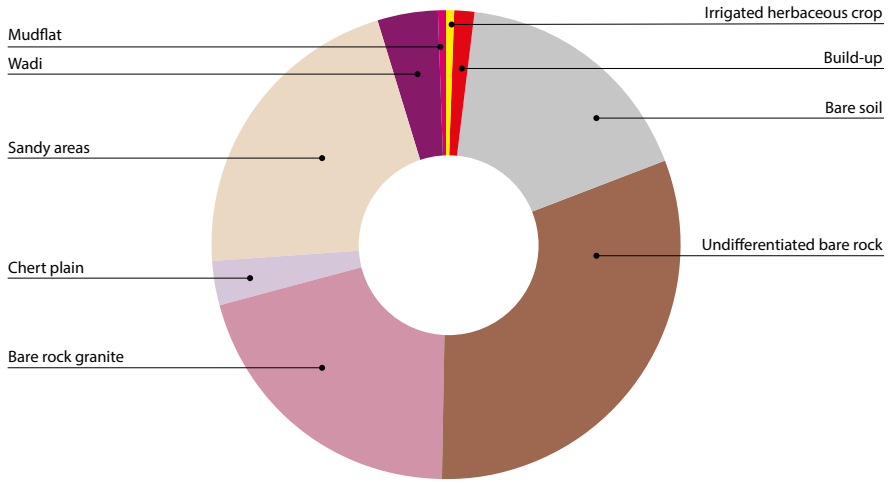
Aqaba

Aqaba, the only sea port in Jordan is situated in the extreme south of the country. Most of the Governorate is covered by bare land.

The estimated population of the Governorate in 2017 was 198 500 (2% of Jordan), of which 85.1% were living in urban centres and the remaining 14.9% in rural areas.

Maize and clover trefoil are Aqaba's largest cultivated annual crop. Fruit trees are mainly grape, olive and date palm.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2015, Aqaba had a population of 37 853 goats (4.4% of the national total) and 20 242 sheep (0.8%).



Rainfall

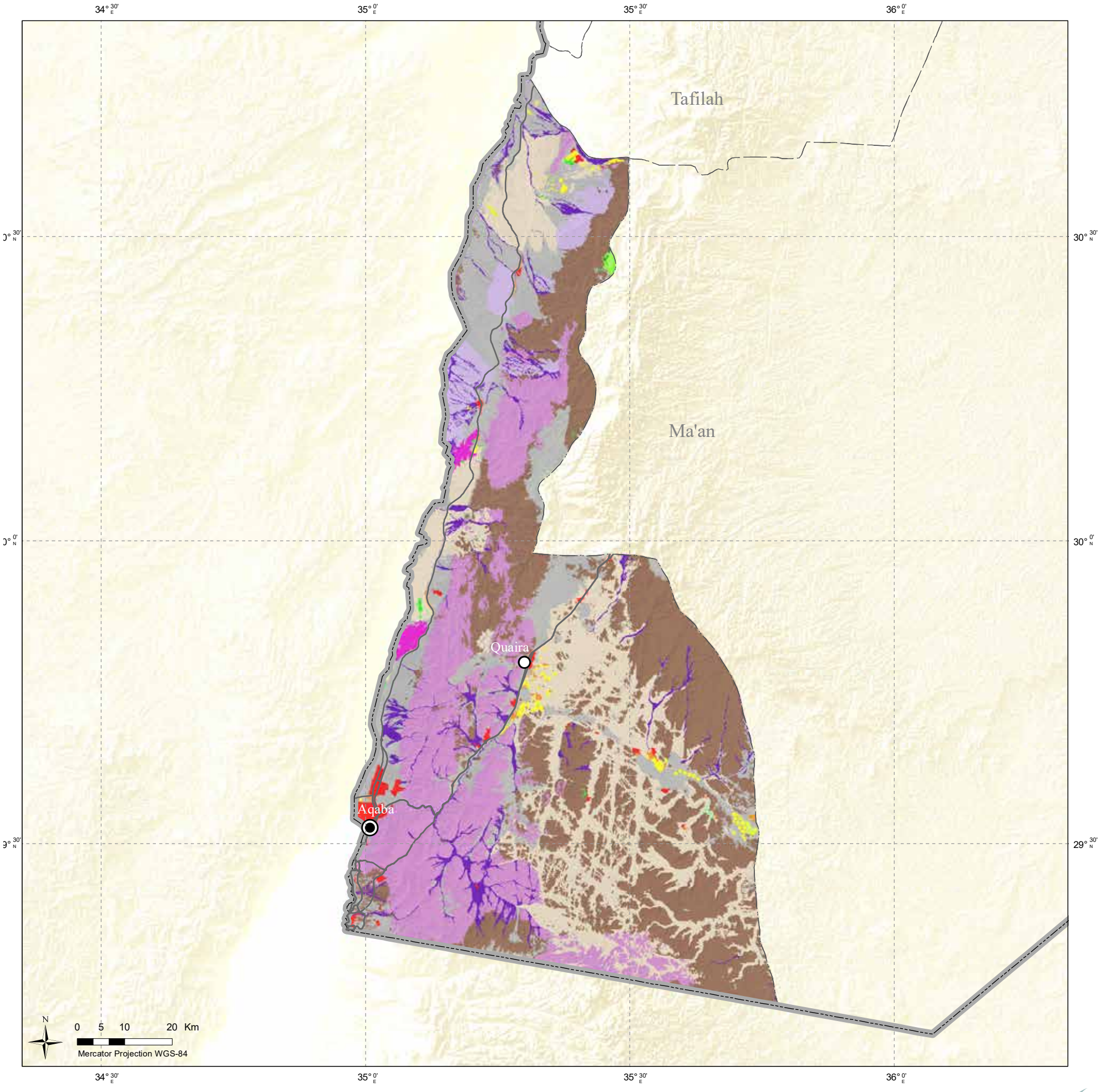
Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Aqaba Airport	13.3	28.3	17.7	38.8	54.1	1.6

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Aqaba. ©David Stanley (CC BY 2.0)

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	Al-Quairah	Qasabet Al- Aqaba	TOTAL km²	TOTAL %
Irrigated orchards	8.87	3.88	**12.75**	**0.2**
Irrigated herbaceous crop	27.53	13.08	**40.61**	**0.6**
Rainfed herbaceous crop	0	0.49	**0.49**	**0**
Rainfed orchards	0	0	**0**	**0**
Closed trees	0.02	0.96	**0.97**	**0**
Open trees	0	5.90	**5.90**	**0.1**
Woody vegetation	0.43	5.12	**5.55**	**0.1**
Grasslands	7.07	4.63	**11.70**	**0.2**
Build-up	13.57	55.65	**69.23**	**1**
Bare soil	305.04	887.76	**1,192.80**	**17.2**
Undifferentiated bare rocks	1,240.12	906.59	**2,146.71**	**31**
Bare rock granite	156.56	1,266.50	**1,423.06**	**20.6**
Chert plain	0	212.69	**212.69**	**3.1**
Basaltic plain	0	0	**0**	**0**
Sandy areas	750.51	715.54	**1,466.05**	**21.2**
Saline soil	0	0.03	**0.03**	**0**
Extraction site	0	1.06	**1.06**	**0**
Saline waterbody	0	4.78	**4.78**	**0.1**
Natural waterbody	0	0.04	**0.04**	**0**
Artificial waterbody	0.52	0.20	**0.73**	**0**
Wetlands	0	0.09	**0.09**	**0**
Wadi	55.10	227.09	**282.19**	**4.1**
Mudflat	0	37.85	**37.85**	**0.5**
TOTAL LAND	**2,565.34**	**4,349.95**	**6,915.29**	**100**



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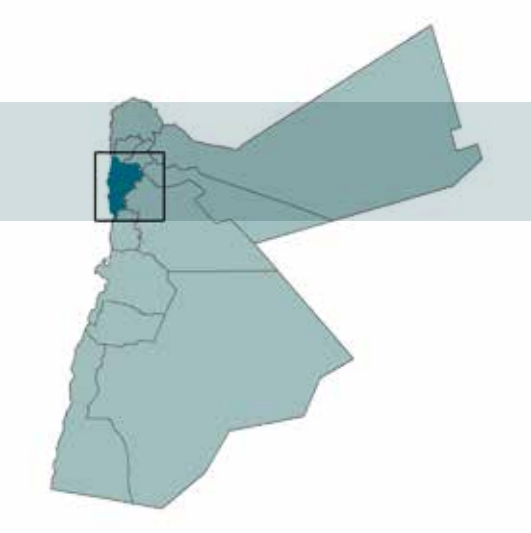


Balqa

The Balqa Governorate is situated in the western part of the Kingdom, characterized by a diversity of climate, terrain and landscape. This is reflected in the variety of land cover types. Its 1 120 square kilometres are distributed across bare as well as agricultural land, grassland and sparse natural forests.

The estimated population of the Governorate in 2017 was 518 600 (5.2 % of Jordan), of which 82.1 % were living in urban centres and the remaining 17.9 % in rural areas.

Wheat and barley are the most cultivated annual crops of Balqa. Most fruit trees are olive trees.

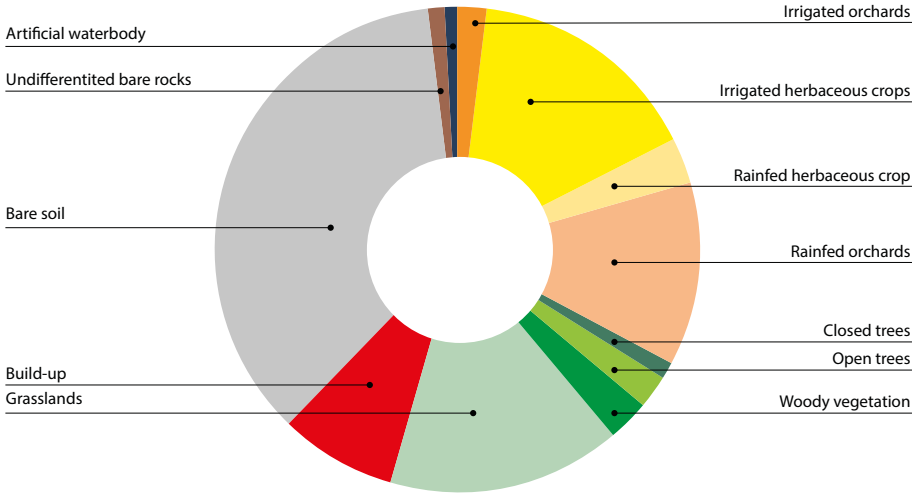
Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2011, Balqa had 3 341 cattle (4.5% of the national total), 91 223 goats (10.6%) and 164 501 sheep (6.3%).

Rainfall

Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Salt	190.5	484.4	585.3	454.8	621.8	569.4
University Farm	-	-	-	-	-	92.4
Dair Alla	99.8	222.3	316.8	277.8	269.9	243.4

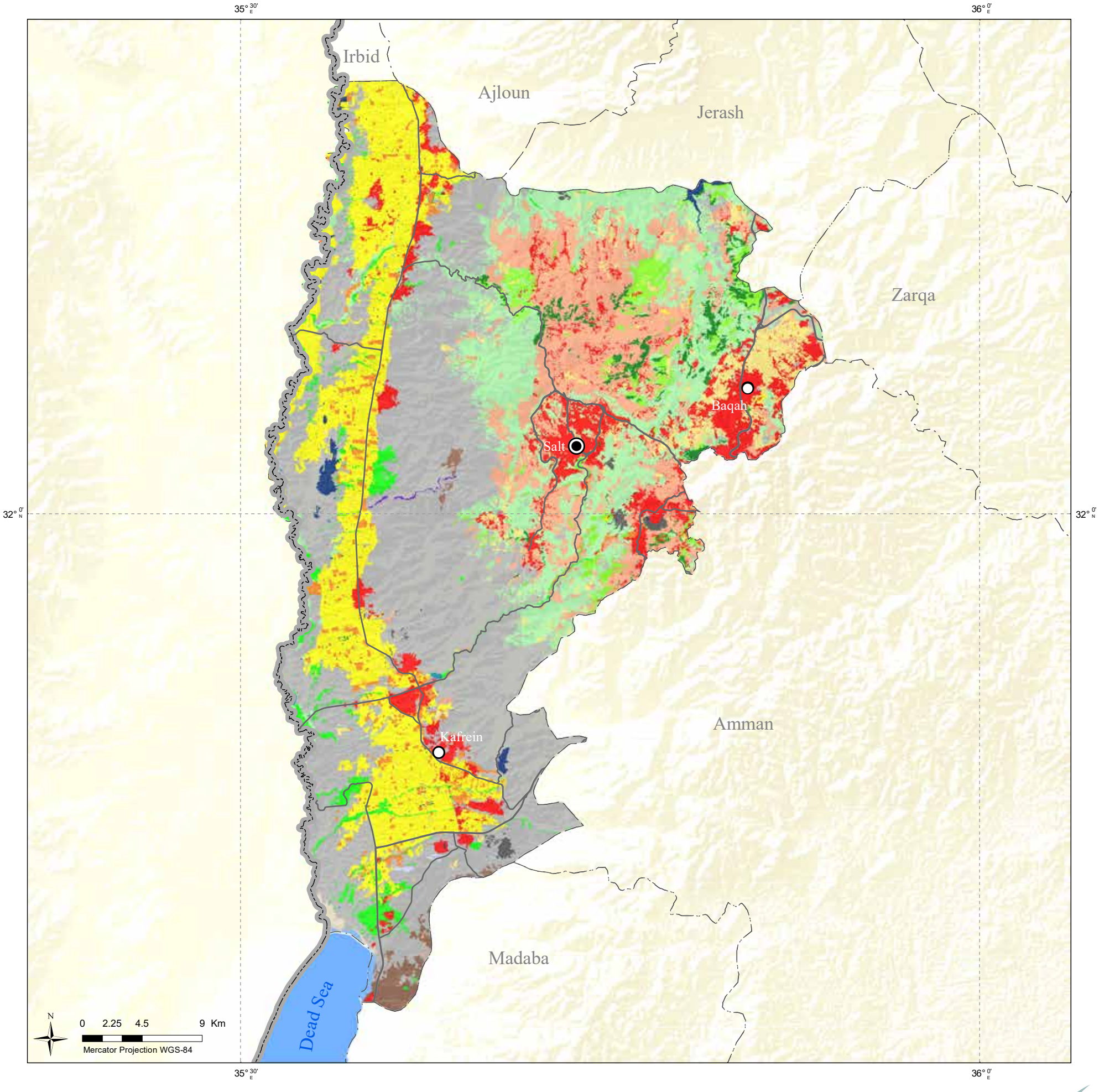
Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Balqa, Dead Sea. ©David Stanley (CC BY 2.0)



Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS: Ain Al-basha	Ash-Shoonah Al-Janoobiah	Dair Alla	Mahes & Al-Fuhais	Qasabet Ai-Balqa'a	TOTAL km²	TOTAL %
Irrig. orchards	0.43	12.44	8.60	0.34	0.57	**22.38**	**2**
Irrig. herb. crop	0.33	73.27	100.31	0.06	0.29	**174.26**	**15.6**
Rainf. herb. crop	19.34	1.11	0.27	0.44	13.15	**34.30**	**3.1**
Rainfed orchards	10.12	0.73	0	10.02	113.18	**134.05**	**12**
Closed trees	5.75	0.08	0.05	0.71	7.47	**14.06**	**1.3**
Open trees	4.77	0.10	0.19	1.47	16.84	**23.37**	**2.1**
Woody vegetation	0.38	16.64	13.12	0	1.48	**31.61**	**2.8**
Grasslands	27.62	2.48	9.99	6.86	127.24	**174.19**	**15.5**
Build-up	21.41	14.90	10.49	7.93	30.06	**84.79**	**7.6**
Bare soil	6.80	157.42	94.20	0.35	142.81	**401.56**	**35.8**
Undiff. bare rocks	0	8.38	0	0	1.43	**9.82**	**0.9**
Bare rock granite	0	0	0	0	0	**0**	**0**
Chert plain	0	0	0	0	0	**0**	**0**
Basaltic plain	0	0	0	0	0	**0**	**0**
Sandy areas	0	2.40	0	0	0	**2.40**	**0.2**
Saline soil	0	0.52	0	0	0	**0.52**	**0**
Extraction site	0	1.34	0	1.71	0.52	**3.57**	**0.3**
Saline waterb.	0	1.60	0	0	0	**1.60**	**0.1**
Natural waterb.	0	0.02	0.27	0	0.03	**0.32**	**0**
Artificial waterb.	1.14	1.44	4.16	0.07	0.06	**6.87**	**0.6**
Wetlands	0	0.37	0.04	0	0	**0.41**	**0**
Wadi	0	0	0.15	0	0.36	**0.51**	**0**
Mudflat	0	0	0	0	0	**0**	**0**
TOTAL LAND	**98.07**	**295.24**	**241.84**	**29.96**	**455.49**	**1,120.60**	**100**



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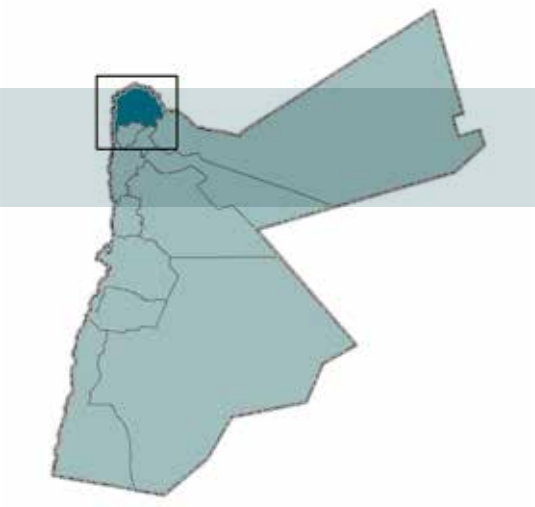
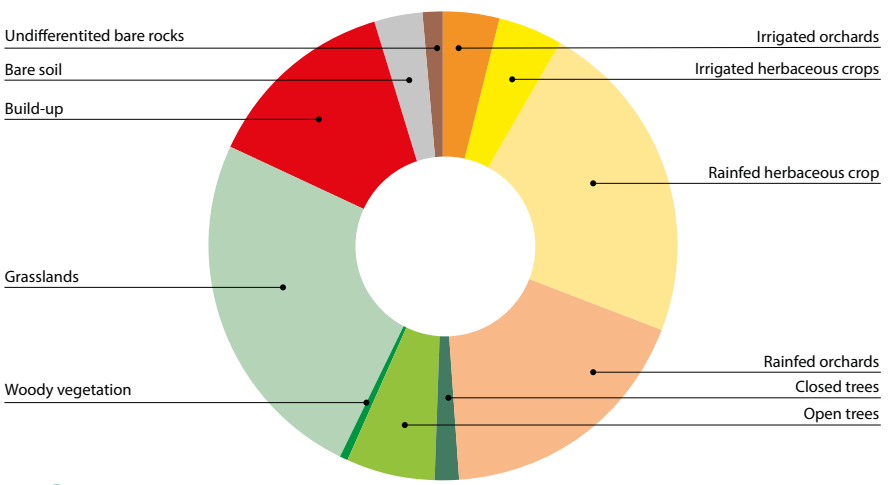


Irbid



The Governorate of Irbid is located at the far northern part of the country, strategic transit station to neighbouring countries, as demonstrated by the presence of important historical and archaeological sites. Extension: approximatively 1,566 km^2, dominated by grassland and rainfed annual cropland. It has a variety of climates due to the complexity of its topography. The estimated population in 2017 was 1,867,000 (18.6% of Jordan), of which 92.4% living in urban centres and the remaining 7.6% in rural areas. It has the highest population density of the country with 1,188 inhabitants per km^2. Wheat and barley are the largest cultivated cereals of Irbid, with lentils, chickpeas and vetch as common field crops. Fruit trees are dominated by olives, and then followed by grapes, almonds and pomegranate. Livestock is one of the most important activities of the agricultural sector of the country for its contribution to employment. Irbid had a population of 16,117 cattle (21.9% of the national population), 75,278 goats (8.8%) and 266,577 sheep (10.3%) in 1/11/2015.

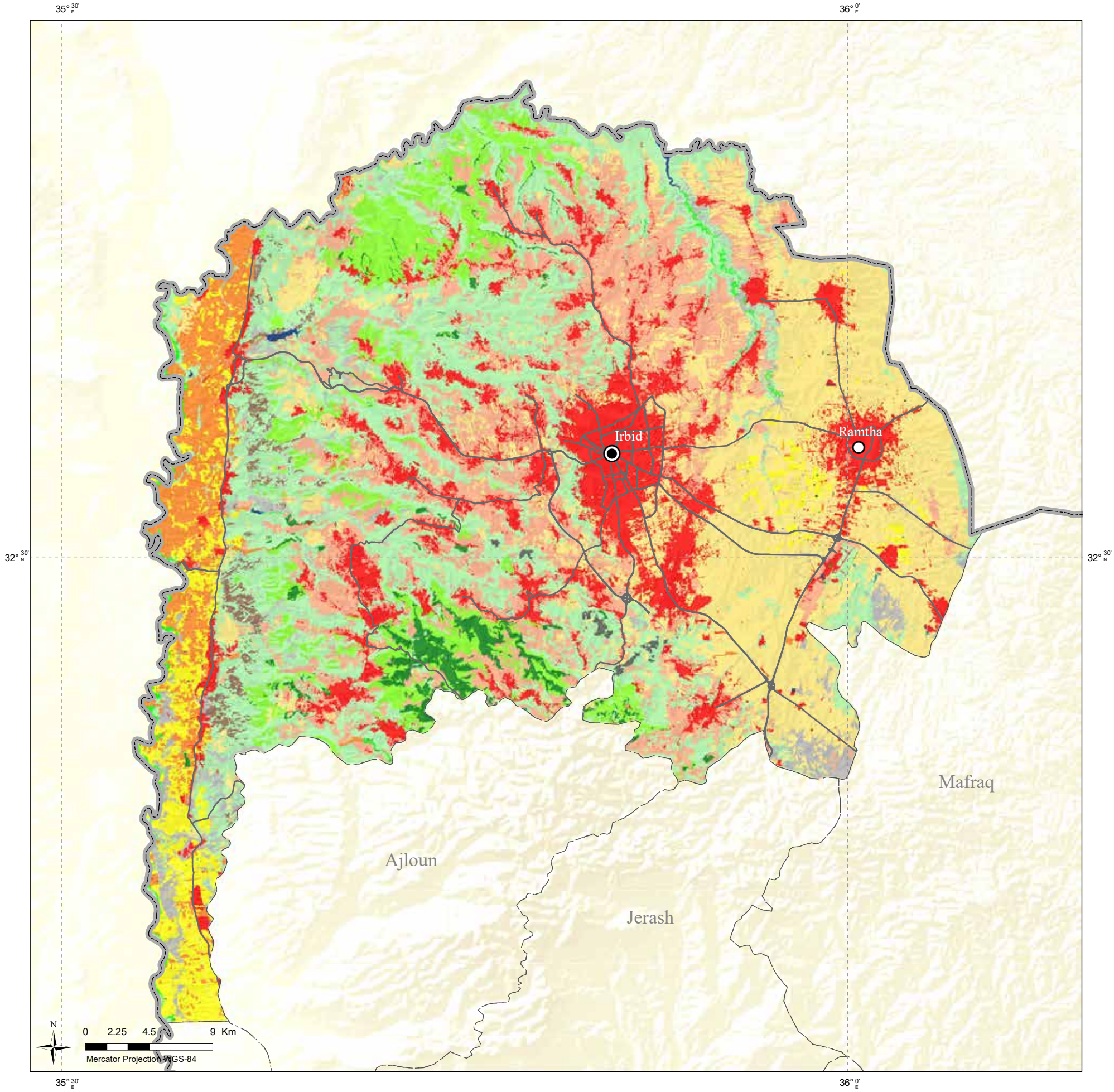
Rainfall

Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Baquoorah	150.7	276	465.8	269.5	489.5	383.5
Wadi El Rayyah	128	234.2	358.3	305.4	301.7	262.7
Ramtha	-	-	-	164.2	258.5	259

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS									TOTAL km^2	TOTAL %
	Al-Aghwar Ash-Shamaliyah	Al-Koorah	Al-Mazar Ash-Shamali	Al-Wastiyyah	Ar-Ramtha	At-Taybeh	Bani Kenanah	Bani Obeid	Qasabet Irbid		
Irrigated orchards	61	0.45	0	0.12	0.20	0.29	0.60	0.35	0	**63**	**4.0**
Irrigated herbaceous crop	61.47	0.02	0	0	8.02	0	0.07	0.67	0.65	**70.90**	**4.5**
Rainfed herbaceous crop	11.21	5.11	5.42	1.43	173.40	6.27	15.90	91.28	40.66	**350.68**	**22.4**
Rainfed orchards	2.52	39.99	25.35	15.73	16.66	14.34	76.28	22.27	68.42	**281.56**	**18**
Closed trees	0.23	12.25	9.06	0.03	0.18	0.17	2.51	1.23	0.30	**25.97**	**1.7**
Open trees	1.39	24.23	10.05	3.91	0	6.79	45.15	4.54	1.12	**97.19**	**6.2**
Woody vegetation	5.89	0.29	0	0.04	1.81	0.09	1.20	0	0.39	**9.71**	**0.6**
Grasslands	55.05	68.75	24.22	15.75	28.43	25.74	85.77	28.12	54.14	**385.97**	**24.6**
Build-up	13.92	20.48	10.60	6.50	31.61	6.47	20.74	28.91	67.63	**206.85**	**13.2**
Bare soil	19.84	4.71	0.43	2.04	10.43	1.44	2	10.36	2.34	**53.59**	**3.4**
Undifferentiated bare rocks	8.83	2.45	0	0.10	0	1.96	0	0	0	**13.35**	**0.9**
Bare rock granite	0	0	0	0	0	0	0	0	0	**0**	**0**
Chert plain	0	0	0	0	0	0	0	0	0	**0**	**0**
Basaltic plain	0	0	0	0	0	0	0	0	0	**0**	**0**
Sandy areas	0	0	0	0	0	0	0	0	0	**0**	**0**
Saline soil	0	0	0	0	0	0	0	0	0	**0**	**0**
Extraction site	0	0	1.19	9	9	9	9	0.89	0.45	**2.53**	**0.2**
Saline waterbody	0	0	0	0	0	0	0	0	0	**0**	**0**
Natural waterbody	2.03	0	0	0	0	0	0.11	0	0	**2.14**	**0.1**
Artificial waterbody	0.92	0.01	0	0.21	0.85	0	0.29	0.04	0.01	**2.32**	**0.1**
Wetlands	0.03	0	0	0	0.18	0	0	0	0	**0.21**	**0**
Wadi	0	0	0	0	0	0	0	0	0	**0**	**0**
Mudflat	0	0	0	0	0	0	0	0	0	**0**	**0**
TOTAL LAND	**244.33**	**178.76**	**86.31**	**45.85**	**271.77**	**63.57**	**250.61**	**188.66**	**236.11**	**1,565.97**	**100**



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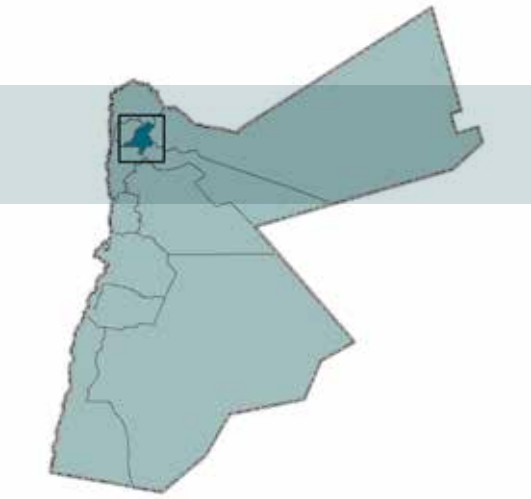


Jerash

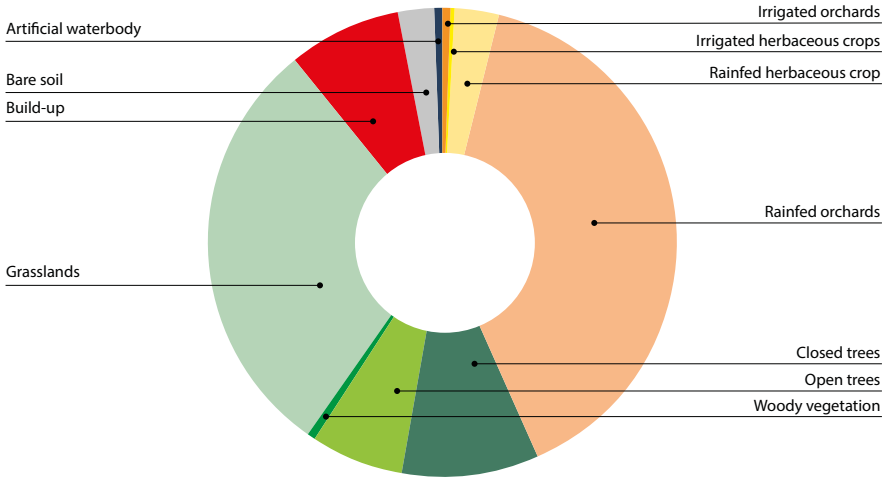
Jerash Governorate is in the northern region of Jordan and is the smallest Governorate in the Kingdom. The landscape is dominated by agricultural land.

The estimated population of the Governorate in 2017 was 250 000 (2.5% of Jordan), of which 77% were living in urban centres and the remaining 23% in rural areas.

Barley, vetch and wheat are the most cultivated annual crops. Fruit trees are mainly olive, followed by grape, citrus fruit, apricot and peach.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector.

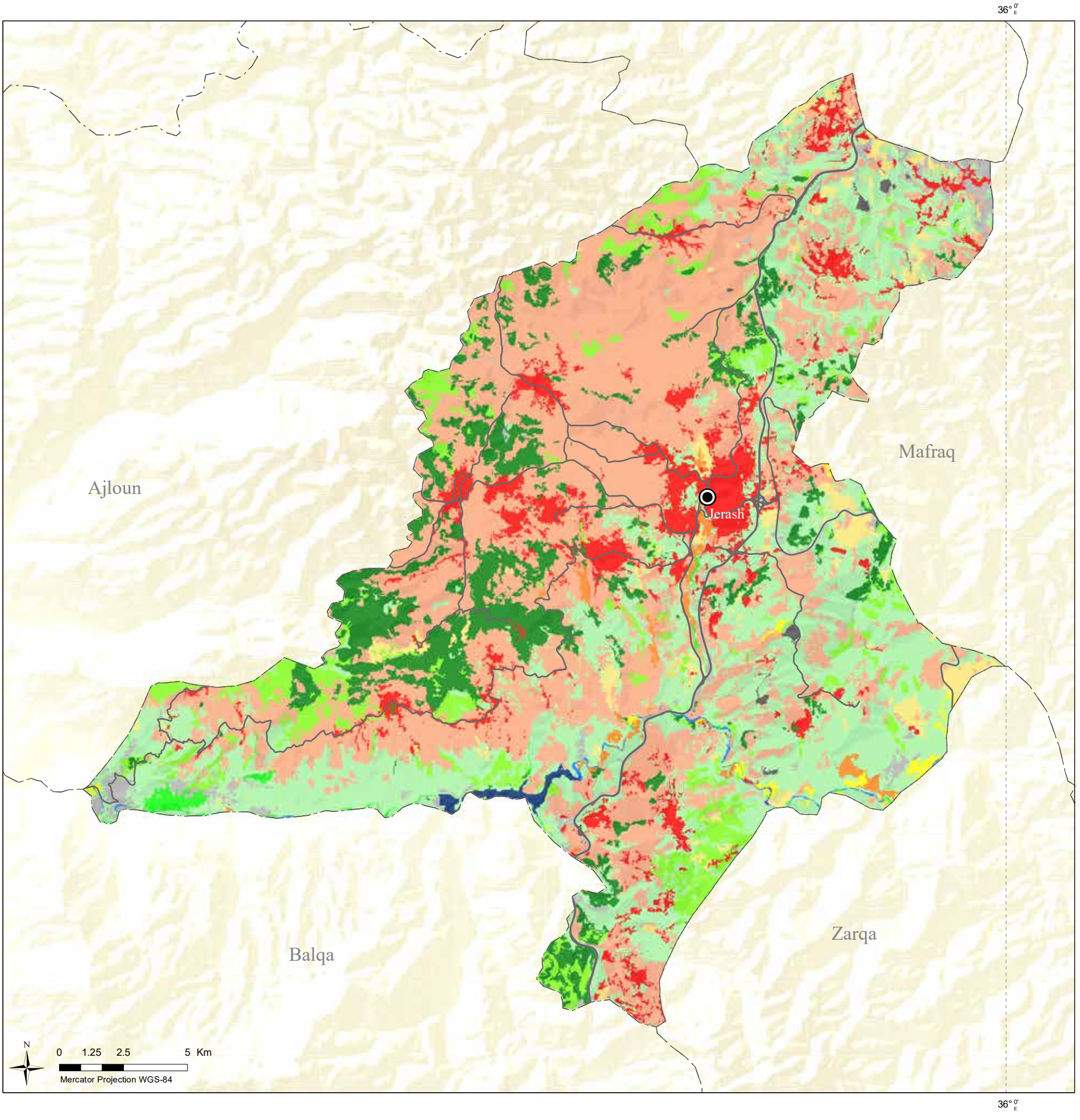
In November 2011, Jerash had 1 667 cattle (2.3% of the national total), 43 708 goats (5.1%) and 12 739 sheep (0.5%).



Jerash, ancient roman columns. ©Edgardo W. Olivera (CC BY 2.0)

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS: Qasabet Jarash	TOTAL km²	TOTAL %
Irrigated orchards	3.02	**3.02**	**0.7**
Irrigated herbaceous crop	1.80	**1.80**	**0.4**
Rainfed herbaceous crop	11.92	**11.92**	**2.9**
Rainfed orchards	161.70	**161.70**	**39.4**
Closed trees	38.14	**38.14**	**9.3**
Open trees	26.96	**26.96**	**6.6**
Woody vegetation	1.81	**1.81**	**0.4**
Grasslands	120.50	**120.50**	**29.4**
Build-up	31.64	**31.64**	**7.7**
Bare soil	10.16	**10.16**	**2.5**
Undifferentiated bare rocks	0	**0**	**0**
Bare rock granite	0	**0**	**0**
Chert plain	0	**0**	**0**
Basaltic plain	0	**0**	**0**
Sandy areas	0	**0**	**0**
Saline soil	0	**0**	**0**
Extraction site	0.76	**0.76**	**0.2**
Saline waterbody	0	**0**	**0**
Natural waterbody	0.65	**0.65**	**0.2**
Artificial waterbody	1.28	**1.28**	**0.3**
Wetlands	0	**0**	**0**
Wadi	0.02	**0.02**	**0**
Mudflat	0	**0**	**0**
TOTAL LAND	**410.37**	**410.37**	**100**



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Karak

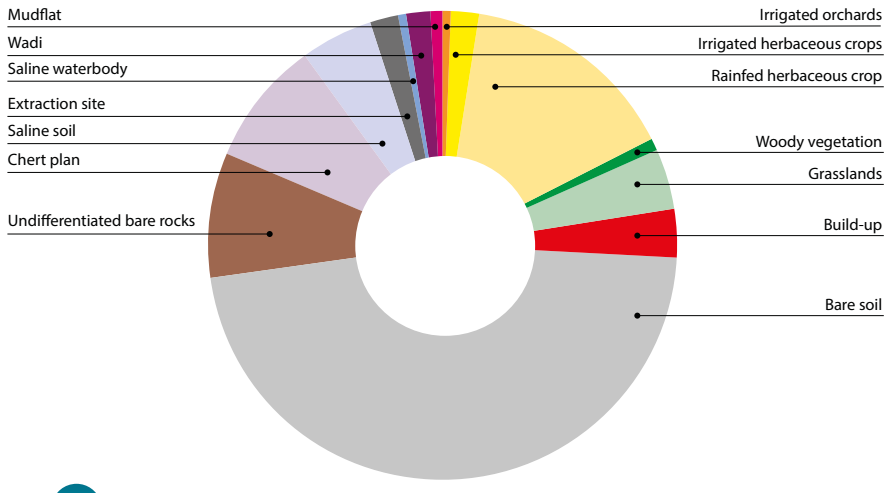
Karak Governorate is in the southern region of Jordan and is largely dependent on agriculture.

The estimated population of the Governorate in 2017 was 333 900 (3.3% of Jordan). It has one the largest rural populations in the country with 40.9% in rural areas and 59.1% living in urban centres.

Barley, wheat and chickpea are the largest cultivated annual crops of Karak. The main fruit trees are olive trees.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector.

In November 2015, Karak had a population of 608 cattle (0.8% of the national population), 101 992 goats (11.9%) and 312 129 sheep (12%).



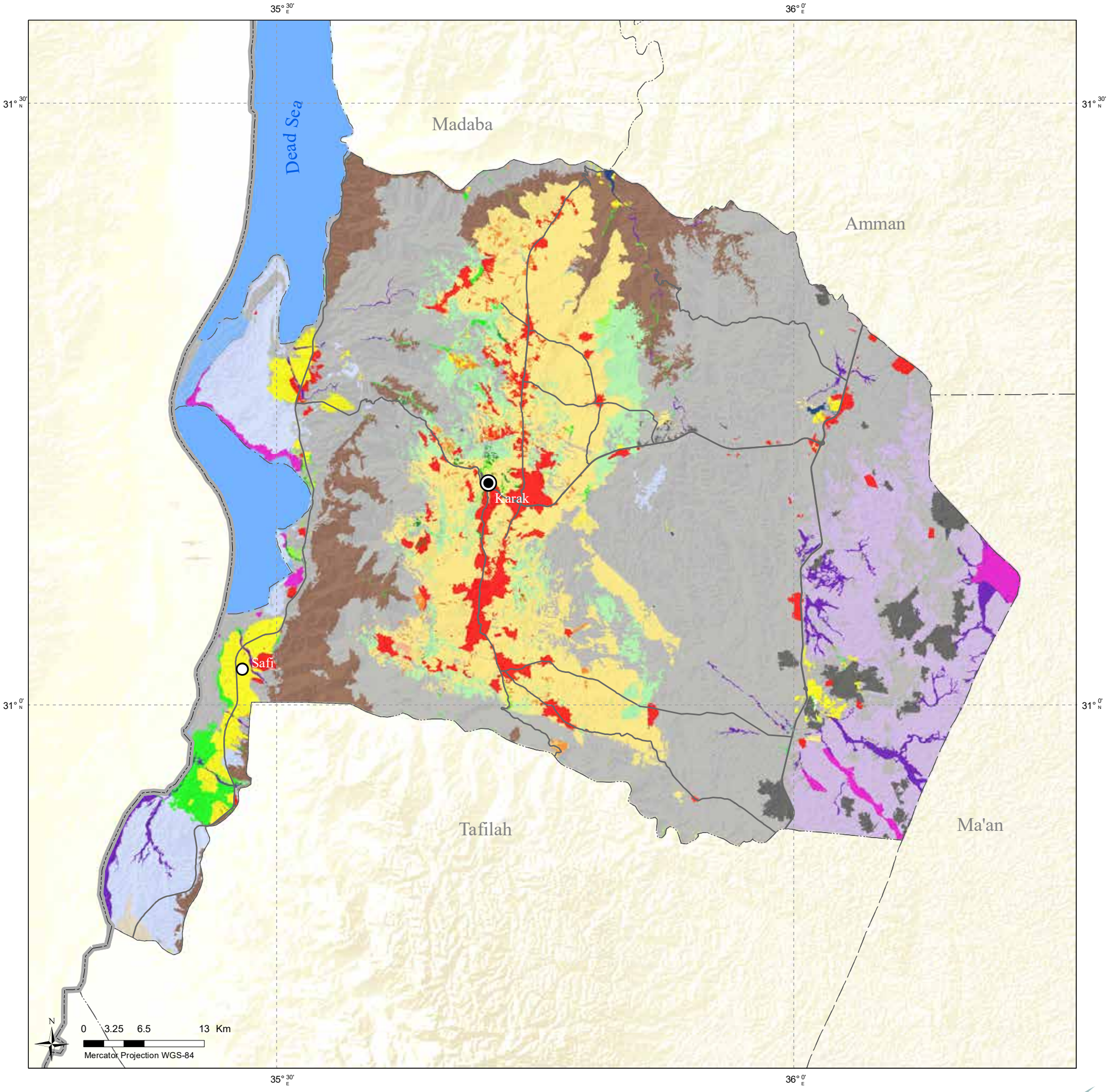
Rainfall

Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Ghor Safi	26	107.9	111.9	106.9	60.1	35.3
Rabbah	198.7	348.7	341.3	364.1	345	299.7
Qetraneh	62.6	114.7	156.3	80.7	91.4	58.7

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS							TOTAL km²	TOTAL %
	Al-Aghwar Al-Janoobiyah	Al-Faqo'e	Al-Mazar Al-Janoobee	Al-Qasr	Ar-Qatraneh	Ayy	Qasabet Al-Karak		
Irrigated orchards	0.27	3.81	5.10	3.95	0.22	0.22	7.25	**20.82**	**0.6**
Irrigated herbaceous crop	62.46	0.29	0.03	0.72	8.95	0	2	**74.45**	**2.1**
Rainfed herbaceous crop	0.06	29.16	148.44	140.55	1.24	20.48	175.28	**515.21**	**14.7**
Rainfed orchards	0	0.31	1.31	0.01	0.13	0	0.19	**1.95**	**0.1**
Closed trees	0.90	0	0.06	0.33	0.12	0.49	1.85	**3.75**	**0.1**
Open trees	2.75	0	0.77	1.09	0	0.08	1.44	**6.13**	**0.2**
Woody vegetation	26.14	1.81	0.34	0.96	1.12	0.03	1.65	**32.05**	**0.9**
Grasslands	0.95	12.07	25.68	19.16	2.85	4.92	82.77	**148.41**	**4.2**
Build-up	8.41	5.50	32.28	12.90	12.06	2.83	41.77	**115.74**	**3.3**
Bare soil	303.24	38.22	256.89	19.49	547.30	27.42	441.51	**1,634.08**	**46.7**
Undifferentiated bare rocks	149.05	10.96	22.27	43.80	64.15	1.06	4.35	**295.64**	**8.4**
Bare rock granite	0	0	0	0	0	0	0	**0**	**0**
Chert plain	0	0	0	0	300.74	0	0.08	**300.83**	**8.6**
Basaltic plain	0	0	0	0	0	0	0	**0**	**0**
Sandy areas	5.43	0	0	0	0	0	0	**5.43**	**0.2**
Saline soil	165.79	0	0	0	0	0	3.93	**169.71**	**4.9**
Extraction site	0.06	0	0	0	68.48	0	1.90	**70.44**	**2**
Saline waterbody	19.95	0	0	0	0	0	0	**19.95**	**0.6**
Natural waterbody	0	0	0	0	0.41	0	0.01	**0.42**	**0**
Artificial waterbody	0.61	0	0.02	0.21	2	0	0.14	**2.98**	**0.1**
Wetlands	0	0	0	0	0.13	0	0.02	**0.15**	**0**
Wadi	15.83	0.01	0.59	0.10	34.01	0	0.73	**51.27**	**1.5**
Mudflat	9.57	0	0	0	20.07	0	0	**29.64**	**0.8**
TOTAL LAND	**771.47**	**102.13**	**493.79**	**243.28**	**1,063.98**	**57.53**	**766.87**	**3,499.05**	**100**



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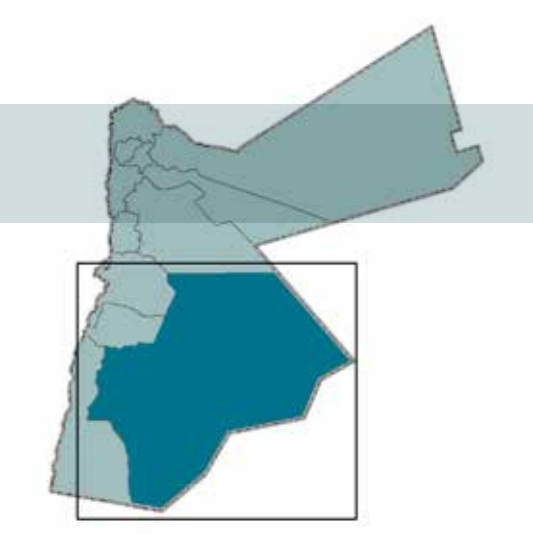


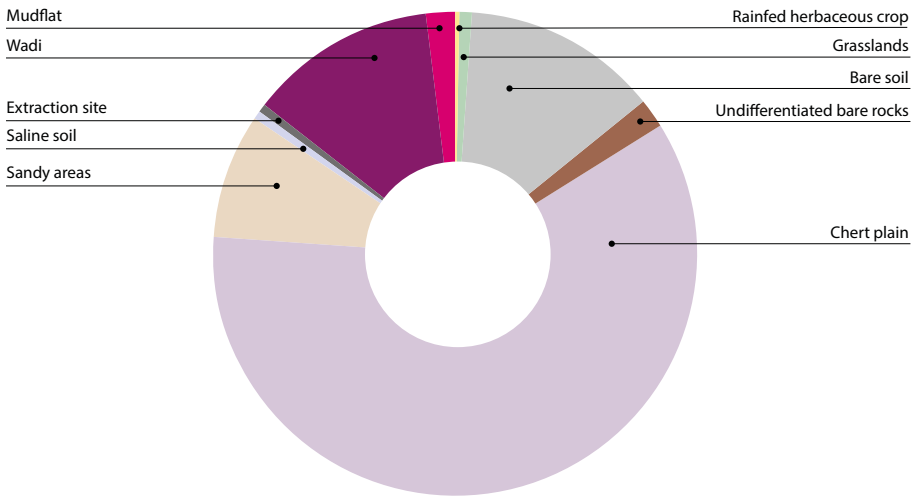
Ma'an

Ma'an, located in the south of Jordan is the largest Governorate, with approximatively 37% of the total land area. It is dominated by bare areas with agricultural and built-up land concentrated in the western part.

The estimated population of the Governorate in 2017 was 152 000 (1.5% of Jordan), with a large share of rural inhabitants (40.9%) with respect to those living in urban areas (59.1%).

Barley, wheat and clover trefoil are the most common annual crops. Most fruit trees are apple and olive.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2015, Ma'an had a population of 263 cattle (0.4% of the national total), 87 140 goats (10.1%) and 132 159 sheep (5.1%).



Rainfall

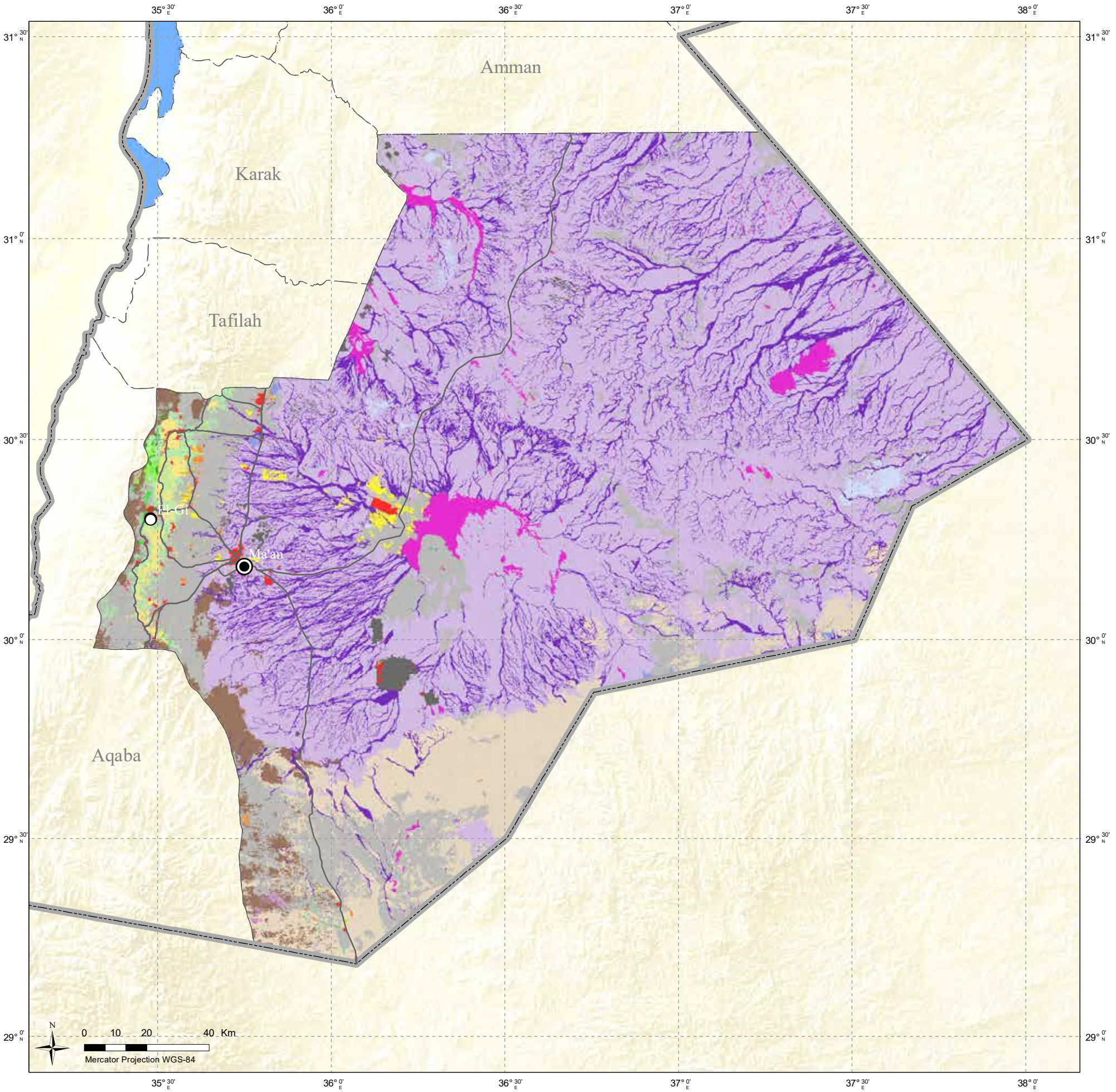
Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Jafer	9.6	81	20.6	41.6	26.4	15
Ma'an Airport	-	61	42.5	64.9	46.1	14.5
Shoabak	116.9	285.2	297.6	255.4	223.3	139.5

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Ma'an, Petra ©Tony Tarry (CC BY 2.0)

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS Al-Huseiniya	Al-Petra	Ar-Ramtha	Ma'an	TOTAL km²	TOTAL %
Irrigated orchards	2.07	1.05	12.09	20.60	**35.80**	**0.1**
Irrig. herb. crop	2.75	0	2.69	98.08	**103.52**	**0.3**
Rainf. herb. crop	4.87	31.72	62.69	76.16	**175.45**	**0.5**
Rainfed orchards	0	0	0.12	0.42	**0.53**	**0**
Closed trees	0	1.12	8.14	0.12	**9.38**	**0**
Open trees	0	2.08	19.95	0.22	**22.25**	**0.1**
Woody vegetation	0.04	7.69	1.80	4.82	**14.34**	**0**
Grasslands	24.33	55.64	91.32	78.20	**249.49**	**0.8**
Build-up	11.06	11.62	10.92	69.70	**103.30**	**0.3**
Bare soil	230.85	70.32	112.93	3,789.57	**4,203.66**	**12.8**
Undiff. bare rocks	0.53	59.08	60.71	562.01	**682.33**	**2.1**
Bare rock granite	0	0	0	18.28	**18.28**	**0.1**
Chert plain	174.42	0	0	19,341.62	**19,516.04**	**59.4**
Basaltic plain	13.70	0	0	25.38	**39.08**	**0.1**
Sandy areas	0	0	0	2,675.20	**2,675.20**	**8.1**
Saline soil	0	0	0	155.80	**155.80**	**0.5**
Extraction site	6.41	0	0.01	211.28	**217.69**	**0.7**
Saline waterb.	0	0	0	0	**0**	**0**
Natural waterb.	0	0.02	0	0.37	**0.39**	**0**
Artificial waterb.	0.22	0.01	0.01	2.34	**2.57**	**0**
Wetlands	0	0	0	2.45	**2.45**	**0**
Wadi	57.16	0	0.36	3,976.38	**4,033.90**	**12.3**
Mudflat	0	0	0	580.05	**580.05**	**1.8**
TOTAL LAND	**528.41**	**240.36**	**383.71**	**31,689.03**	**32,841.52**	**100**



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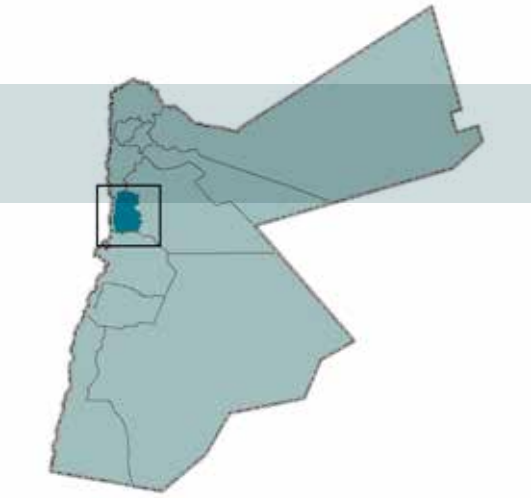


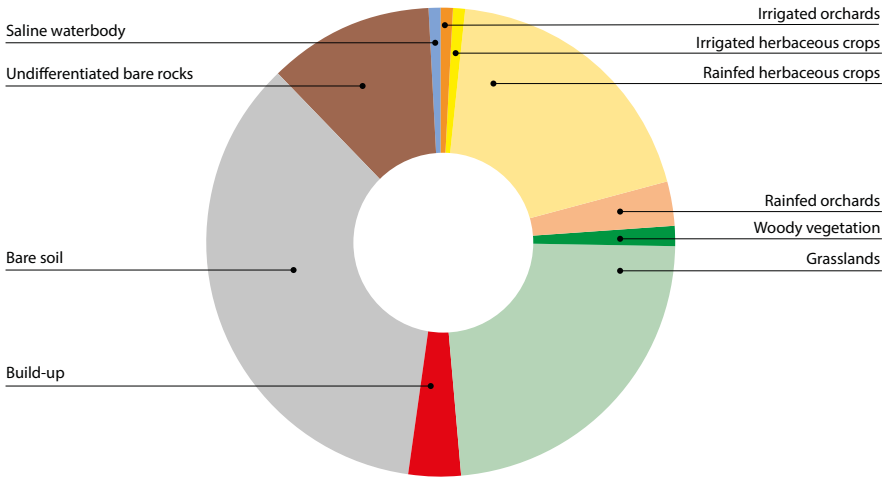
Madaba

Madaba Governorate is in the middle of fertile plains to the south of Amman. This is reflected in the diversity of its agricultural land, irrigated and rainfed crops and orchards.

The estimated population of the Governorate in 2017 was 199 500 (2% of Jordan), of which 78.2% were living in urban centres and 21.8% in rural areas.

Barley and wheat are the most common annual crops. Most fruit trees are olive and grape..

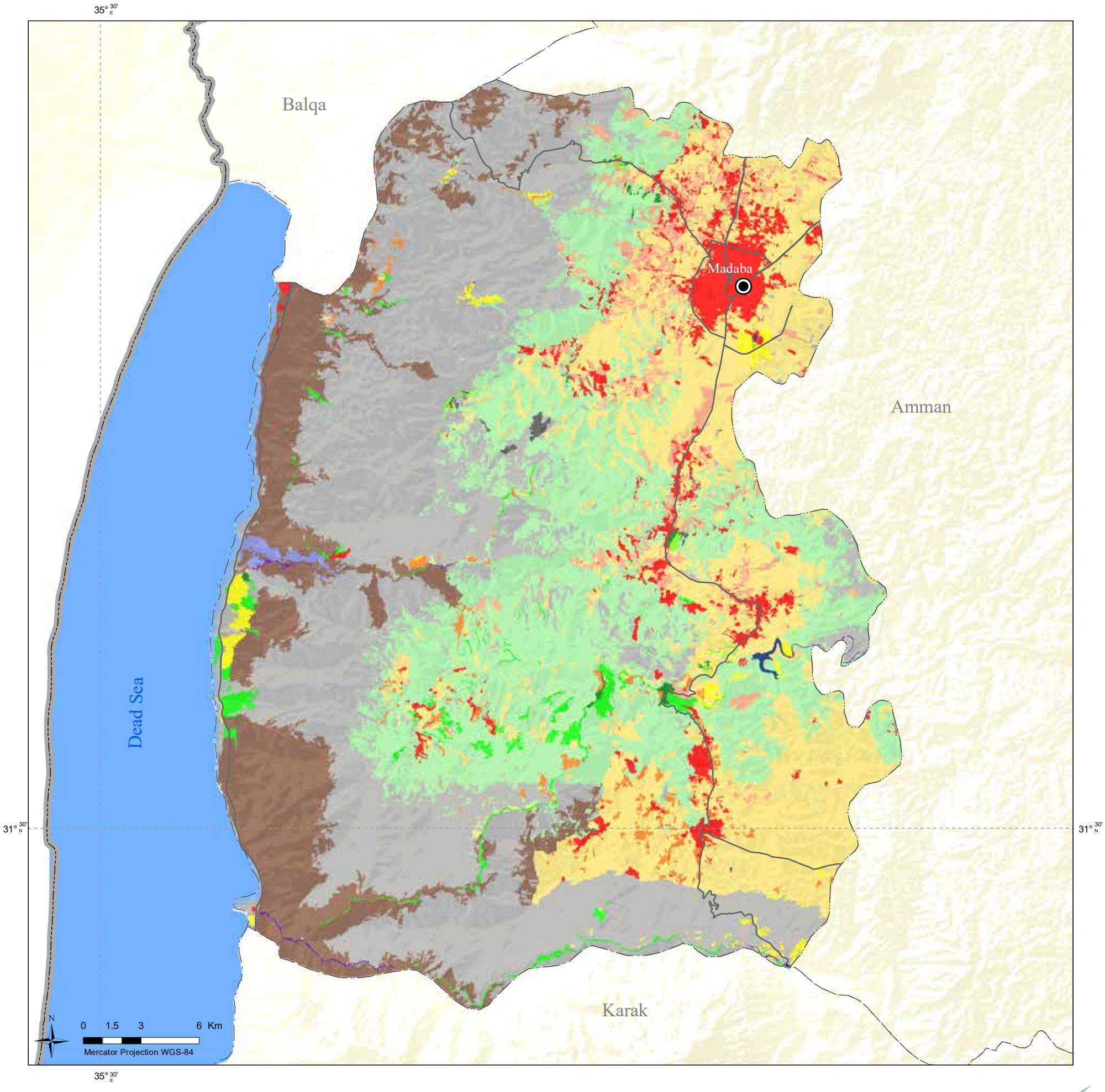
In November 2011, Madaba had 859 cattle (1.2% of the national population), 75 034 goats (8.7%) and 203 481 sheep (7.8%).



Madaba, Dieban's countryside ©Hussein Alazaat (CC BY 2.0)

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS: Dieban	Qasabet Madaba	TOTAL km²	TOTAL %
Irrigated orchards	7.16	1.24	**8.40**	**0.9**
Irrigated herbaceous crop	4.96	2.63	**7.59**	**0.8**
Rainfed herbaceous crop	106.57	74.12	**180.69**	**19.2**
Rainfed orchards	7.59	20.72	**28.31**	**3**
Closed trees	0.92	0.47	**1.39**	**0.1**
Open trees	0.63	0.62	**1.25**	**0.1**
Woody vegetation	10.52	0.90	**11.42**	**1.2**
Grasslands	152.45	65.70	**218.14**	**23.2**
Build-up	11.73	23.34	**35.07**	**3.7**
Bare soil	168.22	162.41	**330.62**	**35.1**
Undifferentiated bare rocks	68.17	39.90	**108.07**	**11.5**
Bare rock granite	0	0	**0**	**0**
Chert plain	0	0	**0**	**0**
Basaltic plain	2.20	0	**2.20**	**0.2**
Sandy areas	0	0	**0**	**0**
Saline soil	0	0	**0**	**0**
Extraction site	0.10	0.86	**0.96**	**0.1**
Saline waterbody	2.35	3.09	**5.43**	**0.6**
Natural waterbody	0	0	**0**	**0**
Artificial waterbody	0.71	0.08	**0.79**	**0.1**
Wetlands	0	0	**0**	**0**
Wadi	0.80	0	**0.80**	**0.1**
Mudflat	0	0	**0**	**0**
TOTAL LAND	**545.07**	**396.07**	**941.14**	**100**



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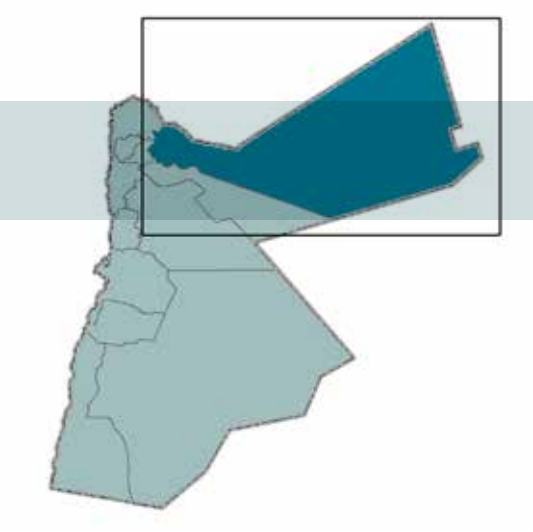


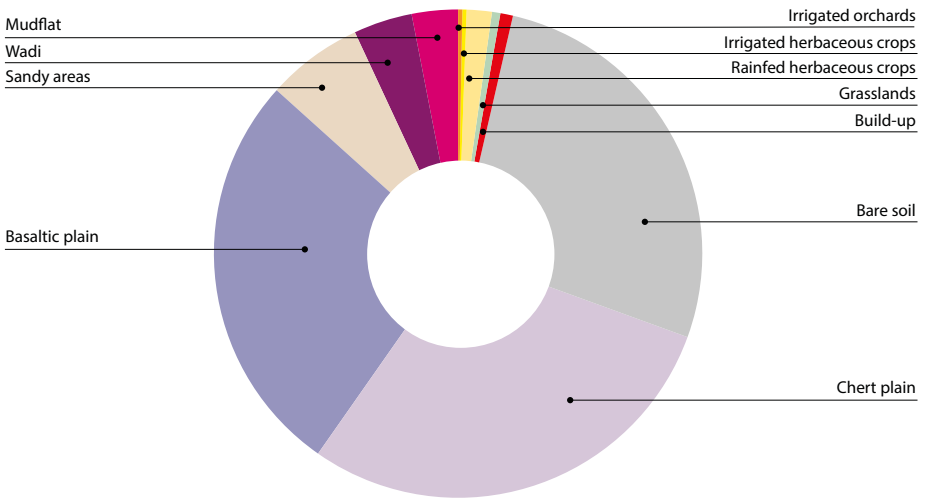
Mafraq

The Governorate of Mafraq is in the northeast of Jordan. It is the second largest Governorate in the Kingdom, largely dominated by bare soil.

The estimated population of the Governorate in 2017 was 580 000 (5.8 % of Jordan), of which 69.7% were living in urban centres and the remaining 30.3 % in rural areas.

Barley, clover trefoil and wheat are the most common annual crops. Most fruit trees are olive and grape.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2011, Mafraq had a total of 10 552 cattle (14.3% of the national total), 96 997 goats (11.3%) and 653 202 sheep (25.2%).



Rainfall

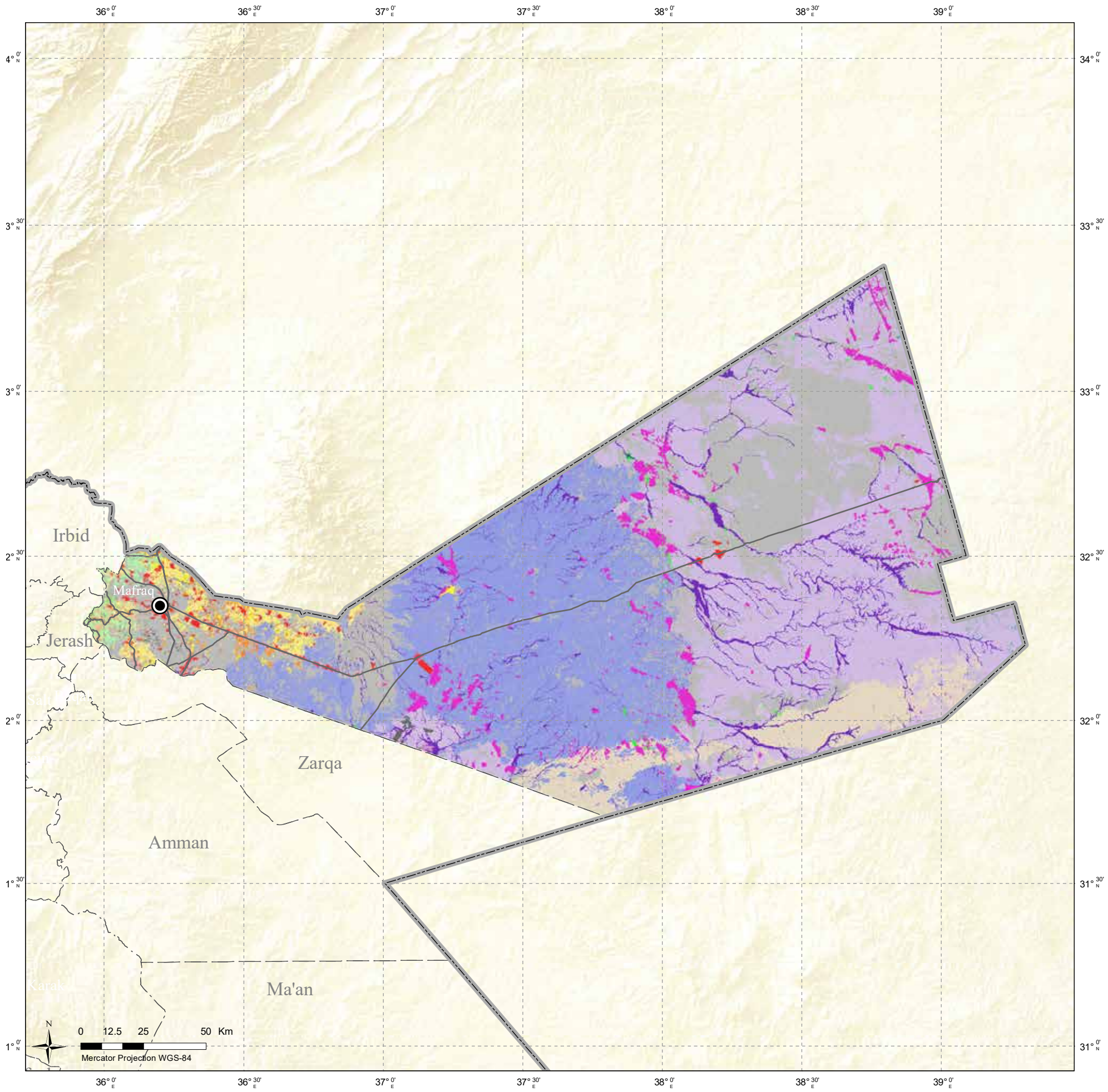
Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Mafraq	77.9	125	176.2	120.7	126.5	165.7
Safawi	78.1	142	63.5	54.8	25.7	37.7
Rwaished	40.2	105.6	60.3	102.9	47.2	15.7

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Mafraq, livestock looking for water. ©FAO/Maria Losacco

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS: Al-Badiah Ash-Shamalieh Al-Gharbieh	Al-Badiah Ash-Shamaliyah	Ar-Rwaished	Qasabet Al-Mafraq	TOTAL km²	TOTAL %
Irrigated orchards	26.36	77.84	0.07	5.30	**109.57**	**0.4**
Irrig. herb. crop	36.56	47.40	6.96	7.54	**98.46**	**0.4**
Rainf. herb. crop	113.18	223.65	0.19	80.73	**417.76**	**1.6**
Rainfed orchards	1.59	0.16	0	46.99	**48.75**	**0.2**
Closed trees	0.01	0	0	2.90	**2.91**	**0**
Open trees	0.01	0	0	3.53	**3.54**	**0**
Woody vegetation	0.09	0.91	50.15	0.01	**51.15**	**0.2**
Grasslands	71.10	0.50	0.03	98.79	**170.42**	**0.6**
Build-up	60.88	73.99	17.03	51.65	**203.55**	**0.8**
Bare soil	345.87	1,319.61	5,156.91	292.39	**7,114.78**	**26.8**
Undif. bare rocks	0	0.61	0	0	**0.61**	**0**
Bare rock granite	0	6.67	0	0	**6.67**	**0**
Chert plain	0	227.67	7,393.12	0	**7,620.79**	**28.8**
Basaltic plain	0	1,442.09	5,666.20	0.02	**7,108.30**	**26.8**
Sandy areas	0	0	1,666.84	0	**1,666.84**	**6.3**
Saline soil	0	0	0	0	**0**	**0**
Extraction site	3.85	22.25	0.71	11.07	**37.88**	**0.1**
Saline waterb.	0	0	0	0	**0**	**0**
Natural waterb.	0.02	0.01	0.06	0.05	**0.15**	**0**
Artificial waterb.	0.89	1.10	3.83	0.06	**5.87**	**0**
Wetlands	1.49	0.32	14.14	0.05	**16**	**0.1**
Wadi	4.17	102.78	913.20	0	**1,020.16**	**3.8**
Mudflat	0	99.98	701.24	0	**801.22**	**3**
TOTAL LAND	**666.07**	**3,647.53**	**21,590.68**	**601.10**	**26,505.37**	**100**



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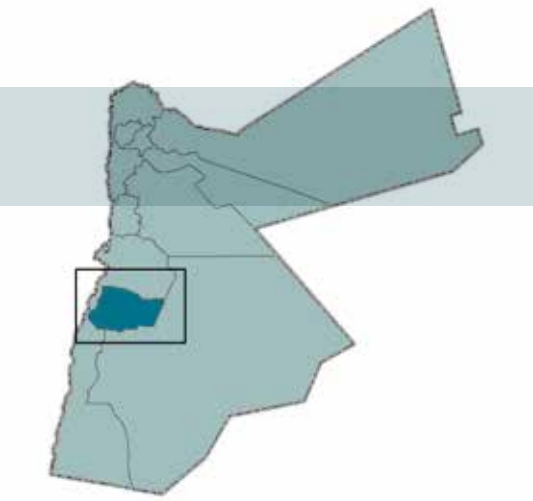


Tafilah

The estimated population of the Governorate in 2017 was 101 600 (1% of Jordan), of which 78% were living in urban centres and the remaining 22% in rural areas.

Barley and wheat are the most common annual crops. Most fruit trees are olive and grape.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector.

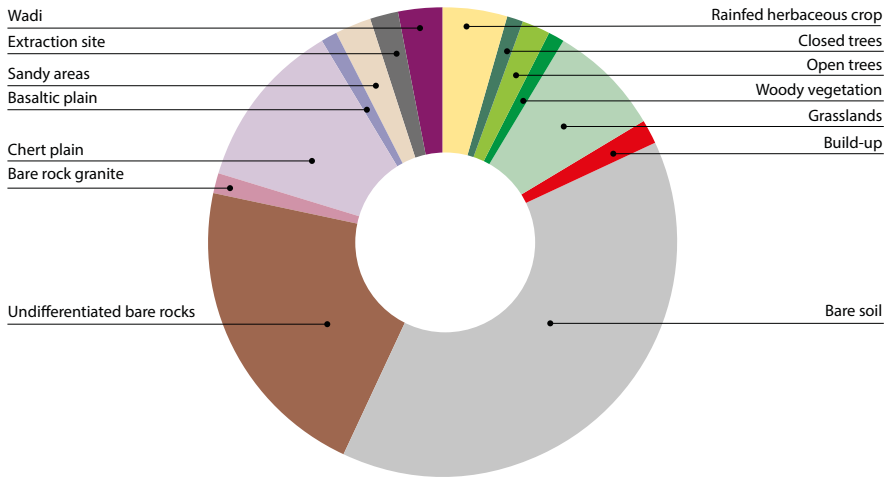
In November 2011, Tafilah had 156 cattle (0.2% of the national total), 30 452 goats (3.5%) and 103 774 sheep (4%).

Rainfall

Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Eiss	65.5	218.9	204.4	202.5	167.3	175.6

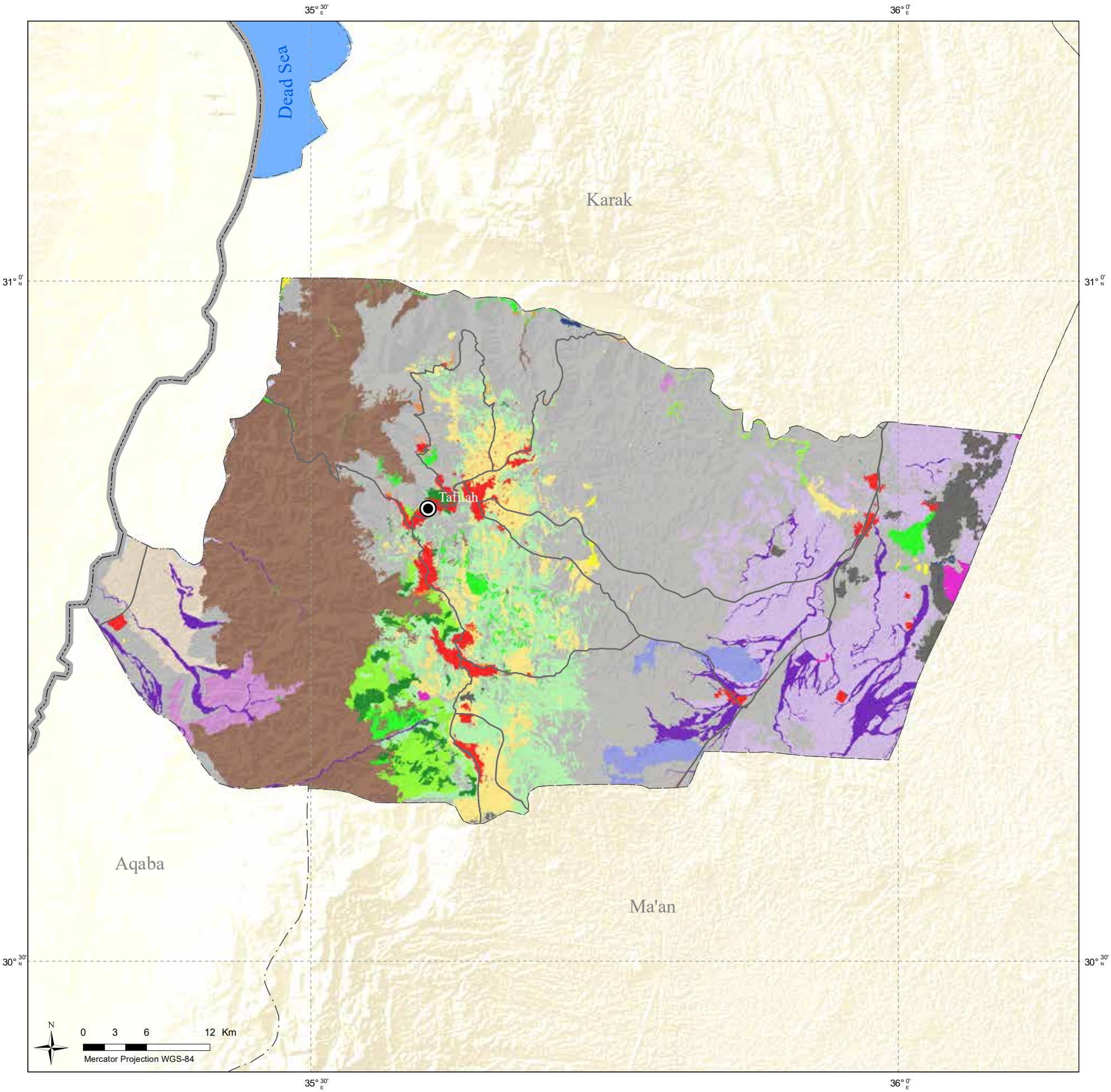
Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Tafilah.©Jvl (CC BY 2.0)



Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	Al-Hasa	Bsaira	Qasabet At-Tafiela	TOTAL km²	TOTAL %
	DISTRICTS				
Irrigated orchards	0.14	0.74	2.95	**3.83**	**0.2**
Irrigated herb. crop	1.94	0.17	0.49	**2.60**	**0.1**
Rainfed herb. crop	10.47	38.21	53.08	**101.76**	**4.6**
Rainfed orchards	0.09	0	2.28	**2.37**	**0.1**
Closed trees	0	17.99	3.87	**21.85**	**1**
Open trees	3.14	36.42	4.61	**44.16**	**2**
Woody vegetation	5.74	7.24	10.87	**23.85**	**1.1**
Grasslands	29.15	67.17	76.77	**173.09**	**7.8**
Build-up	6.44	11.78	20.32	**38.55**	**1.7**
Bare soil	516.42	16.29	320.89	**853.59**	**38.6**
Undiff. bare rocks	0.07	29.30	437.09	**466.45**	**21.1**
Bare rock granite	1.25	0	27.83	**29.08**	**1.3**
Chert plain	255.64	0	0	**255.64**	**11.6**
Basaltic plain	28.94	0	0	**28.94**	**1.3**
Sandy areas	0	0	52.23	**52.23**	**2.4**
Saline soil	0.35	0	2.15	**2.50**	**0.1**
Extraction site	38.90	0.98	0.07	**39.95**	**1.8**
Saline waterbody	0	0	0	**0**	**0**
Natural waterbody	0	0	0	**0**	**0**
Artificial waterbody	0.70	0.01	0.65	**1.35**	**0.1**
Wetlands	0.02	0	0	**0.02**	**0**
Wadi	49.37	0.57	16.13	**66.07**	**3**
Mudflat	4.41	0.54	0	**4.95**	**0.2**
TOTAL LAND	**953.18**	**227.40**	**1,032.26**	**2,212.84**	**100**



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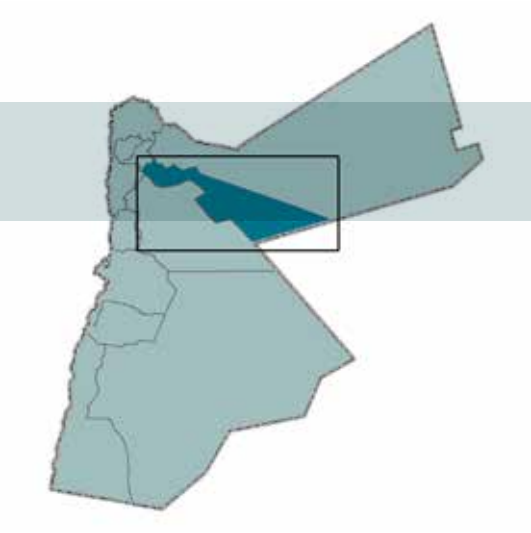


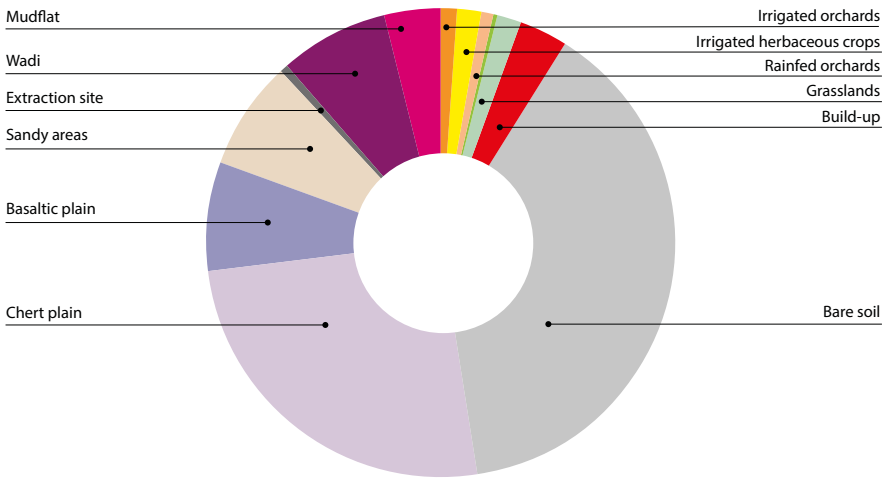
Zarqa

Zarqa Governorate is located northeast of the Capital Amman. It is well connected to the rest of the Kingdom and surrounding countries by a network of main roads.

The estimated population of the Governorate in 2017 was 1 439 500 (14.3 % of Jordan), of which 96.4 % were living in urban centres and the remaining 3.6 % in rural areas.

Barley, clover trefoil and wheat are the most common annual crops. Most fruit trees are olive and grape.

Due to its employment opportunities, livestock is one of the most important activities in the country's agriculture sector. In November 2011, Zarqa had 29 258 cattle (39.8.2% of the national total), 50 718 goats (5.9%) and 182 218 sheep (7%).



Rainfall

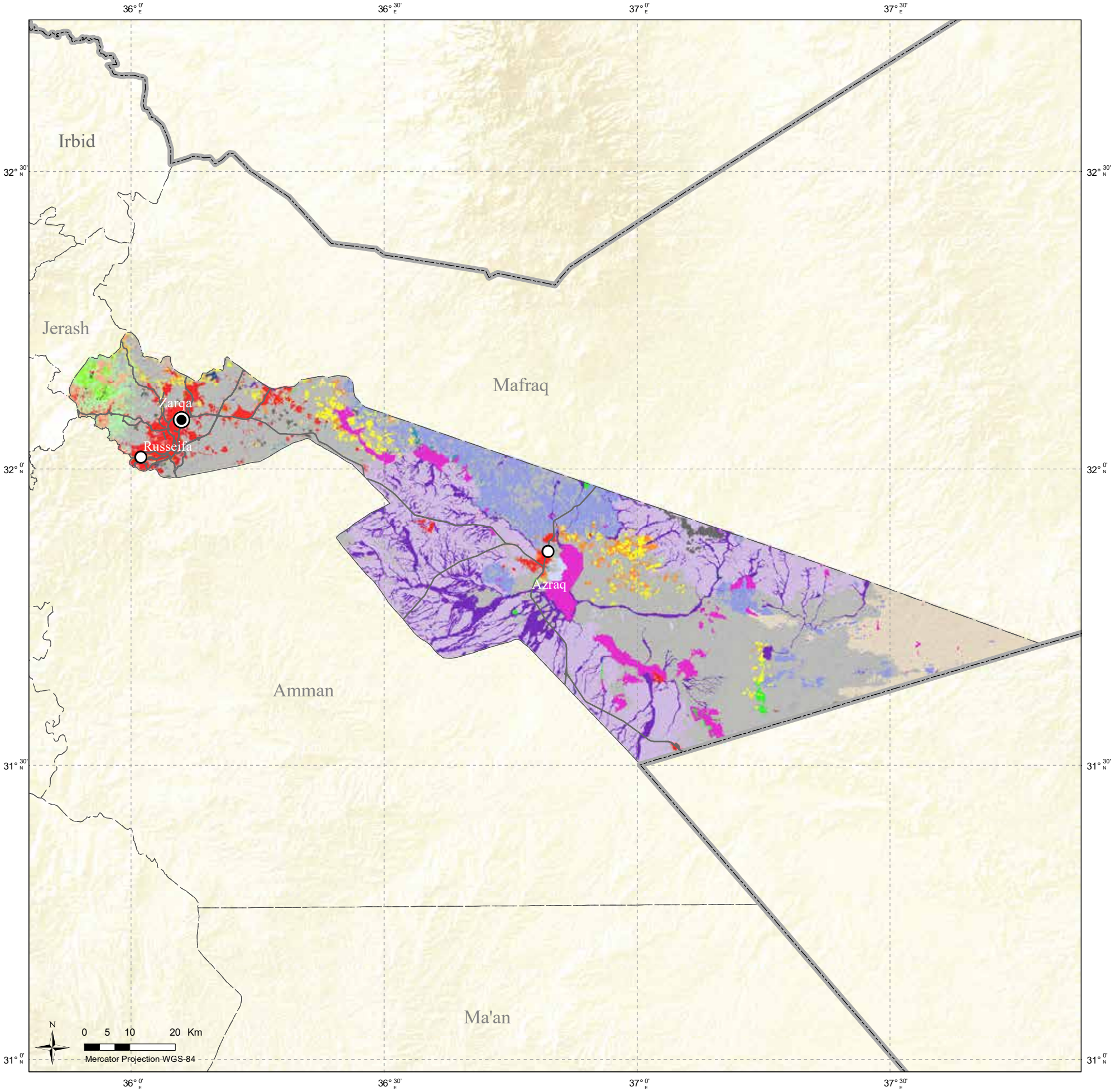
Meteorology Station	2017- 16	2016-15	2015-14	2014-13	2013-12	2012-11
Wadi Dhlail	78.6	102.2	204.3	109.8	123	165.3
Azraq Janoobi	52.9	109.1	86.5	25.9	19.8	31.5

Data recorded at meteo-stations located in various areas of the country, run by the Dept. of Meteorology.

Zarqa, Castle of Azraq.©János Korom Dr. (CC BY-SA 2.0)

Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS: Al-Hashemiyah	Al-Russeifa	Qasabet Al-Zarqa	TOTAL km²	TOTAL %
Irrig. orchards	4.63	0.36	48.76	**53.75**	**1.1**
Irrig. herb. crop	9.24	0.63	78.09	**87.96**	**1.8**
Rainf. herb. crop	2.29	0.43	5.33	**8.05**	**0.2**
Rainfed orchards	3.62	0.16	33.02	**36.79**	**0.8**
Closed trees	0.09	0	1.41	**1.50**	**0**
Open trees	0	0.11	20.17	**20.28**	**0.4**
Woody vegetation	0.35	0	10.52	**10.87**	**0.2**
Grasslands	2.86	0.19	64.20	**67.25**	**1.4**
Build-up	19.43	25.78	118.32	**163.52**	**3.4**
Bare soil	96.49	14.93	1,714.11	**1,825.53**	**38.3**
Undiff. bare rocks	0	0	2.14	**2.14**	**0**
Bare rock granite	0	0	0.90	**0.90**	**0**
Chert plain	0	0	1,197.14	**1,197.14**	**25.1**
Basaltic plain	0.12	0	355.44	**355.57**	**7.5**
Sandy areas	0	0	351.19	**351.19**	**7.4**
Saline soil	0	0	11.62	**11.62**	**0.2**
Extraction site	0.86	1.87	25.79	**28.52**	**0.6**
Saline waterb.	0	0	0	**0**	**0**
Natural waterb.	0.51	0	0.63	**1.14**	**0**
Artificial waterb.	1.94	0	2.14	**4.08**	**0.1**
Wetlands	0.01	0.02	5.49	**5.53**	**0.1**
Wadi	0.13	0	356.99	**357.12**	**7.5**
Mudflat	0	0	171.04	**171.04**	**3.6**
TOTAL LAND	**142.57**	**44.46**	**4,574.45**	**4,761.49**	**100**



"The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement"

Ajloun - View from the Castle. ©Hiking in Jordan (CC BY-SA 2.0)

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