

- ▶ *The Judean Foothills (in Israel) are extremely diverse in climate and natural ecosystems, and have a rich historical and cultural legacy covering several thousand years.*
- ▶ *Climate hazards include consecutive years of drought, heat extremes, and dust storms.*
- ▶ *The rural economy is vulnerable to climate*

► *Key research areas include: plant biodiversity and biomass; forest tree growth; pests and disease; crop yields; choice of cultivars; carbon storage. Areas of integration to be discussed with stakeholders include the availability of water and its allocation; nature conservation; tourism and the rural economy.*

Geography:

The Judean Foothills (31.15 °N - 31.44 °N, 34.48 °E - 35.1 °E) cover an area of around 615 km² and are located in the southern-central part of Israel between the Mediterranean coast and the Judean Mountains (Figure 1). A steep moisture gradient together with topographical variation has created diverse natural vegetation that

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broadly changes from woodland in the northern part of the region to shrubland in the southern part. Species richness is high, totalling 730 plant species, including rare and protected species, dozens of mammals, reptiles and amphibians, and hundreds of bird species³. Land use types include nature reserves, natural and semi-natural woodland and shrubland, planted forests, extensively managed pastures, intensively and extensively managed vineyards and orchards, irrigated and rain-fed seasonal field crops, and small rural settlements. The total population is 6,800 inhabitants with a population density of 11 inhabitants per km². The region

has a rich historical heritage covering several millennia. Numerous archaeological sites within the study area are connected by a network of ancient roads. Among these sites, several mounds were discovered with remains of ancient settlements that include: walls, burial caves, wells, agricultural facilities, fortresses, mosaic floors, churches, and amphitheatres.

Climate:

The region occupies an area of transition between the northern sub-humid and the southern semi-arid Mediterranean climate zones, and spans a mean annual precipitation range of 300-500 mm over a distance of only 40 km along its

north-south axis. As temperatures change little throughout the region (mean temperature range 11-12 °C in January and 25-26 °C in July) a gradient of moisture availability is formed. Climate extremes include drought, such as consecutive years with below average rainfall and prolonged dry periods during the rainy winter season; hot and dry periods, often accompanied by dust storms; thunderstorms producing large precipitation events, runoff and soil erosion; and frosts.

Economy:

The national GDP per capita in 2005 was \$18,097. Agriculture is the key economic sector in the region; 21 of the 22

*Picture 1:
Wild flowers in the
Judean Foothills*



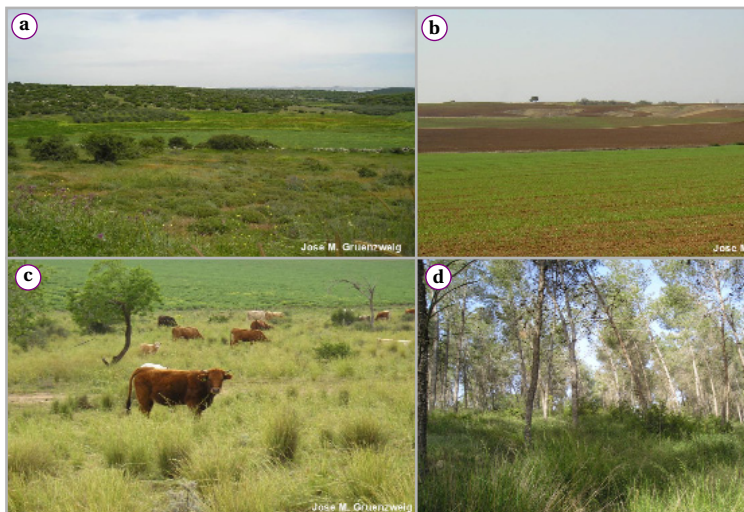
settlements in the region are agricultural. Field crops include wheat, cotton, sunflowers, leguminous food and fodder crops, and horticultural crops, such as citrus fruits, peach and vineyards. Animal husbandry comprises cattle, poultry, sheep and goats. Small industrial enterprises produce plastic products, electronics, food, sand and gravel quarries, wine, and jewellery and other works of art. The service sector is dominated by education, municipal administration and other local services. Tourism, a developing sector in the area,

relies on the rich historical, cultural and natural heritage of the Judean Foothills.

2. Justification

The steep moisture gradient renders the region susceptible to climate variability and vulnerable to climate change impacts. Since water availability is the main limiting factor for organisms in drylands, biological activity changes with moisture at all levels, from leaf-scale photosynthesis to plant growth to landscape-scale vegetation composition and

carbon sequestration. It has been shown, for example, that El Niño events increase precipitation in the region, and accelerate growth rates of Aleppo pine (*Pinus halepensis*), the main tree used for afforestation⁵. In addition, the impact of temperature on pine phenology has shown to be moisture dependent⁴. Previous work on precipitation trends shows increasing annual rainfall amounts on the western slopes of the Judean Mountains, including the Judean Foothills, between 1960 and 1990². Temperature trends for the same period show



Picture 2:
Views from
the Judean
Foothills:
(a) shrubland
near Tzafririm,
(b) fields near
Beit-Nir and
Galon,
(c) rangeland
near Kfar
Menahem,
(d) Amatzia
Forest

decreasing winter temperatures and increasing summer temperatures¹. The municipalities in the Judean Foothills with the support of government agencies and NGOs are currently preparing their candidacy as Biosphere Reserve of UNESCO's *Man and the Biosphere Programme* (www.unesco.org/mab). As part of this process, extensive monitoring and planning activities have culminated in a large database covering the natural, social and historical aspects of the region³. In addition, climate, agriculture and forestry data are available from various other sources. Multiple stakeholders and decision makers involved in the UNESCO candidacy are accessible and include, regional councils, various governmental authorities and administrations, and NGOs.

3. Key Research Issues

Climate issues:

The climate record will be evaluated for long-term trends in precipitation and temperature for several different areas of the

Judean Foothills. In addition, the climate record will be analyzed for trends in the characteristics, severity and duration of extreme events, such as droughts, high temperatures and storms.

Environmental issues:

The natural environment along the precipitation gradient will be analyzed for factors related to plant diversity, plant biomass and cover by woody vegetation. The key issues in forestry (plantations) are tree growth, under storey cover by woody vegetation, and pest outbreak. In agriculture, crop yield and production, selection of crops and cultivars, and sowing and harvest dates will be studied. All types of land use will be investigated for carbon storage.

Social issues:

Population growth and changes in age composition are potential contributors to environmental stress and will be analysed for each settlement in the study area. Water use/resource allocation for different sectors will be evaluated.

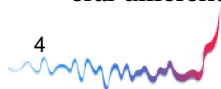
4. Key areas of integration

Research in this case study will evaluate the relationship between changes in: rainfall amount and distribution; temperature; and the frequency, duration and intensity of extreme events on biological variables in natural, forest and agricultural ecosystems (Figure 2). Potential impact pathways are expected to be direct through physiological processes and indirect via the effects of water resources. The association between climate and biological responses will be tested using two approaches: historical records and the precipitation gradient. Climate-driven changes in ecosystems are expected to significantly affect tourism and the rural economy, and initiate policy responses.

5. Regional stakeholders, policy makers, institutions

Governmental organizations:

► Ministry of Environ-



- mental Protection
- Yoav Regional Council
- Israel Nature and National Parks Protection Authority
- Israel National Commission for UNESCO

Non-governmental organizations:

- Jewish National Fund – Forestry service

- Society for the Protection of Nature in Israel
- Growers of South Judea - Local agricultural organisation

There is some evidence of autonomous adaptation to climate change at the local level through practices such as afforestation and conservation tillage. In addition, farmers use drought-

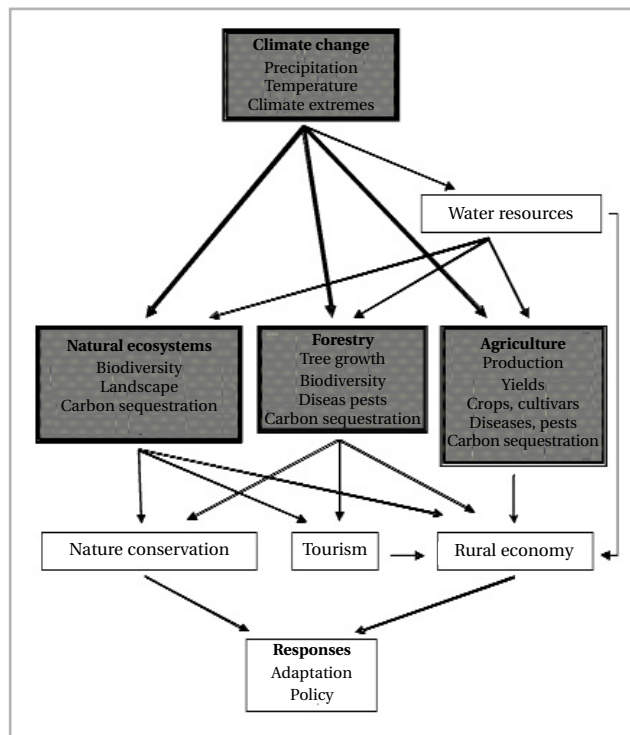
adapted cultivars on dry shallow soils and in the drier southern part of the study area. No planned adaptation measures have been identified.

6. Data availability

Climate data:

Climate data are available from existing sources: Israel Meteorological Service, Ministry of Agriculture and Rural

*Figure 2:
Conceptual framework
for the integrated
assessment of climate
change impacts in the
Judean Foothills:
double framed boxes -
key research areas;
single framed boxes -
discussion with
stakeholders*



Development, Ministry of Environmental Protection, and Municipal Associations for the Environment. There is a network of 11 meteorological stations distributed across the study area and at least eight more stations less than 14 km from its borders. All stations provide rainfall data with many series commencing around the year 1950. Nine stations provide temperature, with records from two of them starting as early as 1920, two commencing in 1950 and the remainder beginning more recently. In addition, relative humidity is measured at eight stations and global radiation at three stations. A long-established station and two newer stations (from 2001) provide data on wind speed, wind direction and evaporation. Most of the data are of high quality and are available at a daily resolution. Some of the early data are presented at a lower resolution (monthly or annual).

Natural ecosystems data: Information about natural ecosystems is avail-

able from three single surveys conducted by the 'Society for the Protection of Nature' in Israel. The surveys took place at three different sites along the precipitation gradient of the study area; one survey in each of the northern, central and southern areas. These surveys provide geological, botanical, zoological and landscape data. In addition, a separate survey will be undertaken for plant diversity, tree/shrub cover and carbon storage at a few selected sites along the precipitation gradient.

Forest data:

Forest inventory data are available from the Jewish National Fund (the forest service of Israel). There are 15 forestry plantations inside the study area. For each forest, 2-4 high quality surveys have been conducted during the period 1994 - 2007. For the years 1982 - 1994, an undetermined number of surveys of probably lower quality have been undertaken. The inventories include tree species, tree size, tree density and trunk volume. Records of forest pest outbreaks are

available from around the year 1985. In addition, several studies in the past 30 years provide data on the response of tree growth and development to rainfall. A survey of carbon storage will be conducted for a selected number of forests along the precipitation gradient.

Agricultural data:

Data on agricultural area, type of crop and water use are available from the Central Bureau of Statistics for a number of years at the municipal level. At the settlement scale, information on crop production, yield, duration, water use and pests and diseases is available for at least the previous ten years. A survey of carbon storage will be undertaken for a number of field sites selected along the precipitation gradient.

Social data:

Population data are available from the Central Bureau of Statistics and from Stern et al. (2004) for each settlement every 1 - 13 years, for the period 1948 - 2006.



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