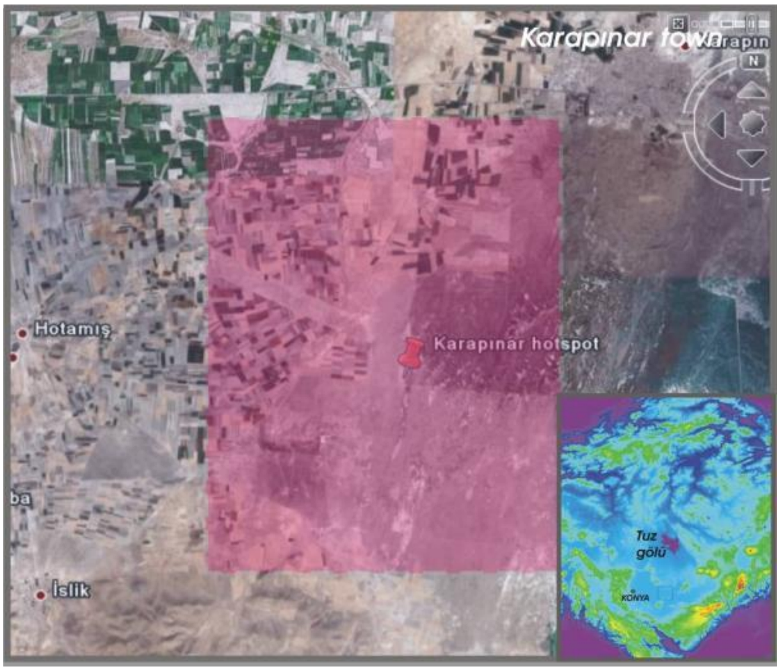
Karapinar study site, Turkey

Highlights of work carried out in the DESIRE Project
Based on research at Eskisehir Osmangazi University, Turkey

The study site

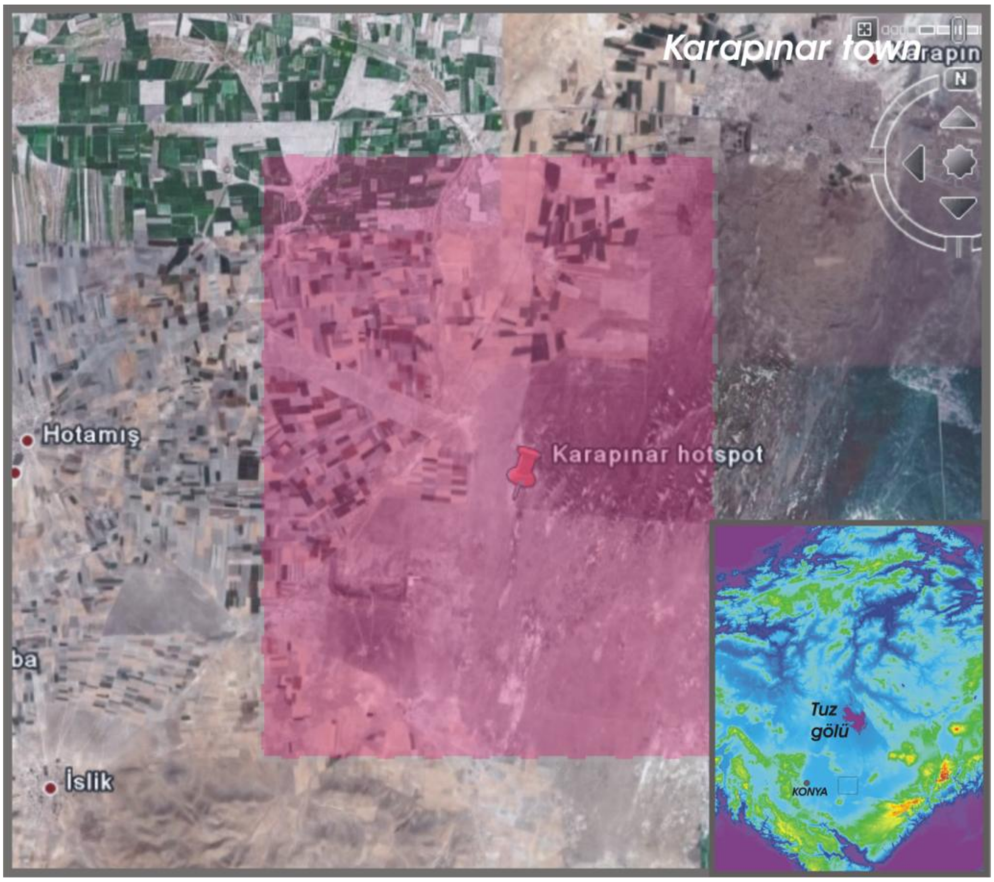
The Karapinar study site is located in the Great Konya Basin of south central Anatolia, 120 km east of Konya city. It includes a military zone (40 km^2) and an erosion control area (15 km^2).

- **Coordinates:** Latitude: 37°37'8"N; Longitude: 33°21'20"E
- **Size:** 156 km^2
- **Altitude:** 998 – 1178 m
- **Precipitation:** 285 mm
- **Average temperature:** 11.5°C
- **Land use:** arable land (cereals, maize, sugar beet, potato, fodder crops), pastures
- **Main degradation processes:** wind erosion, salinization, overgrazing
- **Major drivers of degradation:** inappropriate land management and irrigation techniques



Study site location

General information



The Karapınar study site is located in the Great Konya Basin of south central Anatolia, 120 km east of the Konya city. It covers a rectangular surface of about 150 km^2. Within the study site area, a military restricted zone (ca. 40 km^2) there are also an erosion control area (15 km^2). This area is immediately thought of when addressing the desertification phenomena in Turkey since many prevention and mitigation measures were implemented in the region in the past, particularly between 1960s and 1970s. Climate here is the driest of the country. The ground is covered by loose detrital/lacustrine deposits. These materials are very sensitive to long-lasting wind activity (sometimes 18-25 m/sec) when coupled with deterioration of weak vegetation cover and unsuitable agricultural practices. Wind erosion and dune shift has reached an intolerable level from the viewpoints of agriculture and quality of life in the early 1960s when an experimental station was implemented to halt and reverse this degradation process.

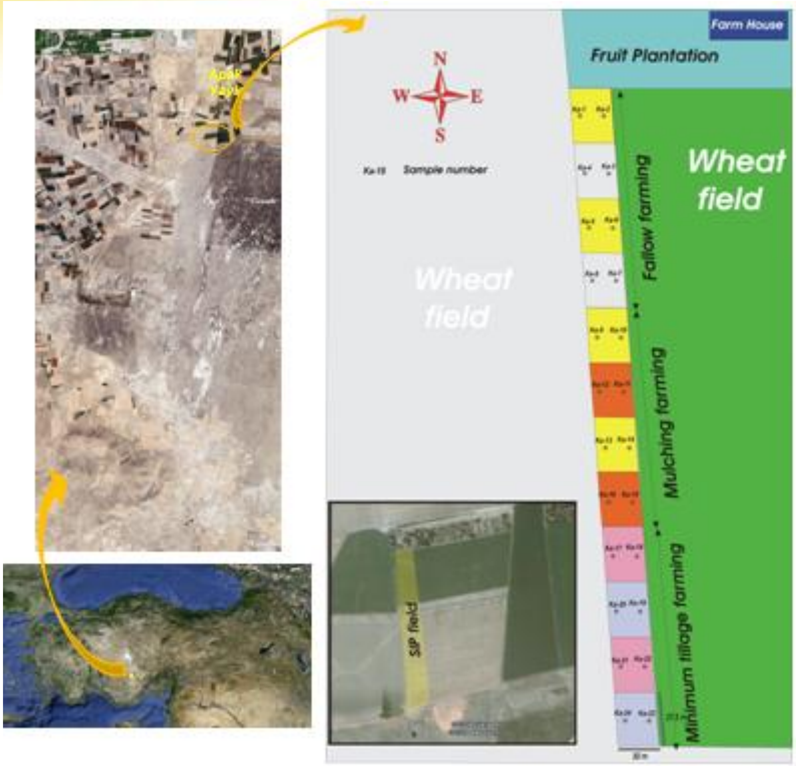
Konya plain, and particularly the Karapınar area was famous for cereal production and animal feeding (esp. sheep) in the 1960s. In the last years irrigated agriculture is rapidly extending due to market pressure, developing techniques and subsidies. As a result ground water levels have dropped dramatically. Although the applied prevention measures provided a significant success, their prominence has decreased with time while the socio-economic and climatic factors worsened. The area also has been affected by secondary salinization that resulted from intense use of groundwater. There are projects to prevent desertification including the application suitable agricultural techniques, forestation and sustainable exploitation of ground water.

The only language used in communication (written and oral) among people is Turkish since the area historically comprises only the Turkmen population.

Sand dunes in the Karapınar area

Preservation efforts in 1960s in the Karapınar area

Outcomes of preservation measures in 2000s




View of the applications of technologies in strip farming plan, Karapınar hotspot

Karapınar area is the most arid part of Anatolia and still greatly suffers from wind erosion due to unfavorable soil texture and meteorological conditions though intensive use of ground water resources.

Wind erosion is the major problem here, on the sediments remaining from an ancient shallow lake. The main crops are cereals and sugar beet. Various soil protection and irrigation strategies have been tried in the past, some successfully and some not. Strategies will reviewed and suggested improvements, including rotational grazing, strip cropping and drip irrigation, will be tested.

Tree colonisation of sand dunes, Karapinar, Turkey. © S. Açýkalin

Socio-economic description

The Karapınar study site has a total surface area of 70 km^2 and comprises 4 small villages (*oba* in Turkish) together with a part of the erosion control area and a forbidden military zone. Villages have been mostly inhabited temporarily during the intense agricultural activity season from May to September in the last 20-30 years. Most of the inhabitants live in the remaining cold seasons in the Karapınar town, (ca 30.000 people).

In the Karapinar study site, of the 80 women interviewed, there are only two women who graduated from secondary school. Of the 80 men reached with questionaire, 73 percent of men graduated from primary school. Only 4 men graduated from secondary school. There is only one man who graduated from university.

Annual household income of the farmers is mostly very low. More than 50 % of the population survives but goes hungry. Farmers with reasonable income rates make 25 % of the total. Only 7 % of the farmers, probably large field owners, do gain annually up to 5.000 €.

Ann. income range (NTL)*	900-999	1000-4999	5.000-9.999	10.000-19.999	20.000-25.000	30.000-40.000	70.000-126.000
% of population	37	15	9	24	8	4	3

* 1NTL (New Turkish Lira)=0.5 € (May 2008)

The farmers in the region dominantly gain their lives from partial support of crop production for cash backed by animal feeding since none of these activities are generally economic alone. Wind erosion, accompanied with drought and lowering of groundwater levels, accompanied with economy-politics adversely affect by causing decreasing crop production, increasing input costs and hence increase poverty and economic-social unrest. The majority of the farmers (66%) think that the coming days will be worse than the past.

Exploitation of land resources is at a maximum though villagers have a deep insight into cause and effect with regard to degradation phenomena. No measures have apparently been taken with respect to wind erosion by farmers themselves. Meadows are still under ultimate exploitation without any future perspective and legislative restructuring. The main driver behind these apparent adverse situations are always pressure of the market that is so fluctuating and unstable. Educating the local people with information about newer agricultural techniques of whatever kind by governmental organizations is almost absent.

Institutional and political setting

Soil Management in the study area is mainly achieved by the branch of a state organization (General Directorate of Rural Services, Soil and Water Research Institute, Provincial Agricultural Directorate). The former organization is recently officially bound to local governors and its efficacy is very low. Soil and water Research Institute is directly authorized to battle with the wind erosion and this has been successfully done until recently. But decreasing official research funds allocated to this company refrain activities.

Within the boundary of the municipality land use decision-maker is the municipality board elected by the city's people. There is a wealth of farmer organizations on the issues of funding, irrigation, fertilization etc. A recently installed local analysis facility is also available.

TEMA is the only countrywide NGO in terms of desertification that paying significant education efforts of different levels (for pupils, villagers etc.). She sometimes leads for reforestation activities and other social projects too.

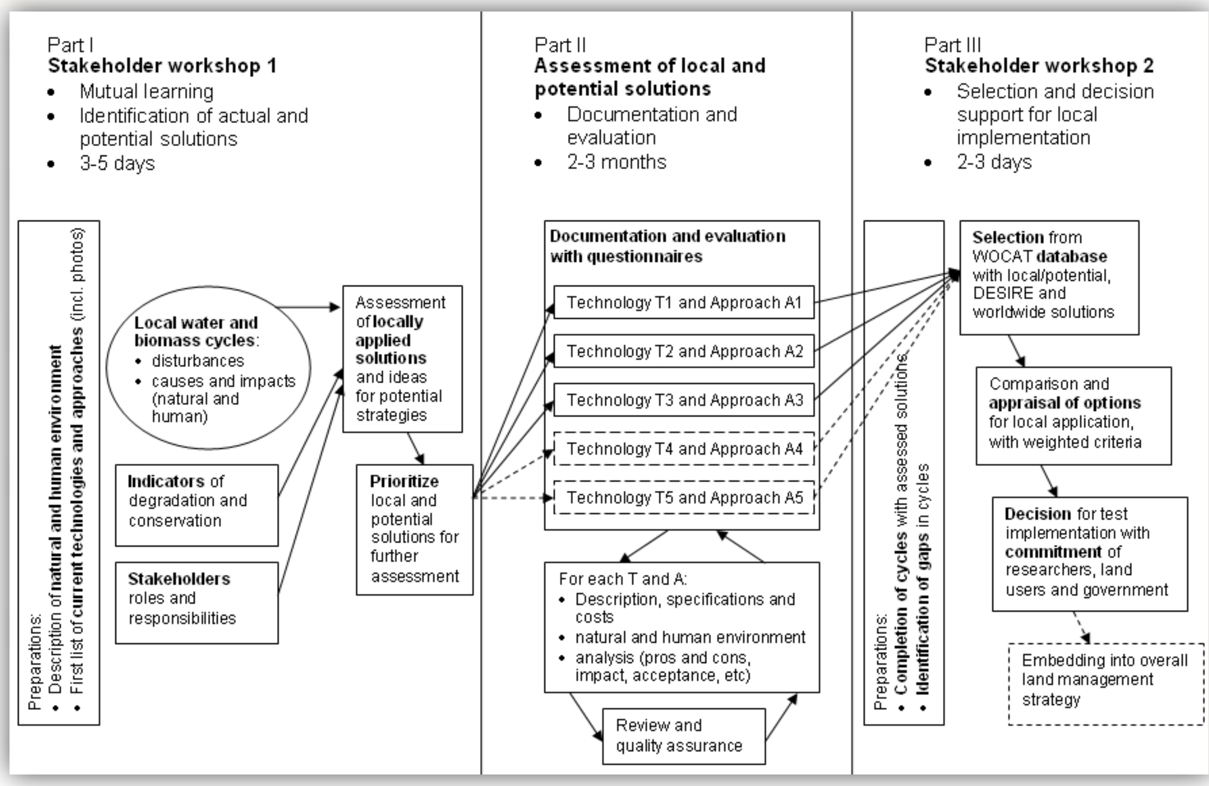
The existing law (no: 5403) on soil preservation and land use is effective since 2005. According to law and related regulations, a soil protection board headed by local governor (vali) was formed in each province to provide all kinds of insights on the issues of land use and soil preservation. This structure also is authorized to decide and make researches on land degradation processes and new soil preservation projects. As a general view of existing legislative situation, main gap is in the coordination of various institutions and structure related to land use and soil protection. Low capacity of the country in creating multidisciplinary studies, as well as lack of base data and maps on land use and soil protection forms other major bottlenecks.

Extension and training services in the Karapınar hotspot is extremely scarce. Villagers quoted similar to other Turkish hotspot Eskişehir, that there is no periodic information flow given by related state institutions. As with those institutions, availability of suitable (number, quality etc.) personnel is very rare mostly due to existing state personnel regime (i.e. trend to decrease number of officials). In our opinion based on the experience of structuring DESIRE project at the beginning, long lasting political turmoil alters technical staff too. Villagers frequently complain that the extension staffs prefer staying at offices instead of informing farmers in the field.

Relevant end-users / stakeholder groups

- **State Water Works**, Konya Branch: The local branch of the primary executive state agency for elimination of adverse effects of Turkey's surface and groundwater and putting them in public utilization in various ways such as hydropower, irrigation, domestic and industrial use. • Soil and Water Research Institute: Branch of an organization (The Ministry of Agriculture and Rural Service) aimed at the Development, conservation or suitable exploitation of the soil and water resources.
- **General Directorate of Provincial Agriculture, Konya branch:** A governmental organization responsible for the promotion of agricultural activities within the provincial boundaries.
- **Provincial Directorate for the Environment and Forestry:** Local state branch responsible for reforestation and environmental rehabilitation and protection.
- **TEMA**: A Turkish NGO for combating soil erosion, for restoration and protection of natural habitats.
- **Foundation For The Reinforcement of the General Directorate of National Parks and Game-Wild Life** : A Turkish NGO focused on the protection of environment with its wild life.
- **UNCCD National Focal point**: The national connection point against desertification founded under the Research, planning and co-ordination board of the Ministry of Environment and Forestry.
- **Karapınar Municipality**: Decision maker and execution authority within the municipality boundary with respect to land management and related subjects.
- **Local Irrigation Unions**: The union of villagers (end-users) for provision of surface and ground waters to their farms.
- **Local Farmer Unions**: The union of villagers for increasing the crop amount and quality.
- **Misnistry of National Education, Directorate of Karapınar District:** Governmental organization, authorized for the education of children from primary school to lycee.
- **Selçuk University, Faculty of Agriculture:** A developed rural university, with many raised academics, and undergraduate and postgraduates in various fields of agriculture.

Workshops for researchers and stakeholders to select sustainable land management technologies



Researchers talked with local people and policy makers, and together they decided on the best options for sustainable land use. In the DESIRE Project the three Parts to WOCAT methodology were developed as outlined above. This provides decision support for choosing technologies suited to the local environment that includes social, cultural and economic factors as well as physical science.

In every DESIRE study site researchers and stakeholders held two workshops to arrive at their selection of approaches and technologies. At the first workshop stakeholders learned about how degradation happens, and how to avoid it.

An experimental setup in the strip farming plan was designed to test the effect of wind erosion upon the wheat crop (Ekiz bread wheat). Technologies applied were minimum tillage, ploughed stubble fallowing and stubble fallowing. The area of each technology was further divided into 4 parcels 2 of them were sowed that year with a fallow parcel in-between.

Three technologies were implemented in the SIP area in the light of stakeholder meetings ;

1. Minimum tillage

2. Mulching

3. Fallow

Modes of implementation;

▸ For each technology, we selected four 30 m x 37.5 m sized rectangular parcels lined up in N-S (dominant wind direction).

▸ In the implementation of each technology, two strips were left fallow. These fallow strips were used as the control parcel.

View of the southern half of the SIP area.

In the first DESIRE workshops minimum tillage technology was considered beneficial to be tested. Indicators showing the changing topsoil quality and water demand were evaluated over two years. Project staff added stubble farming as a technology for testing. Then a final workshop was held in June, 2011 in Karapınar to discover the response of the stakeholders.

The stakeholders used the criteria from workshop 2 to assess the significance of remediation technologies. This showed that stubble farming is slightly advantageous by increasing yield, and probably encouraging soil and water conservation as well. Minimum tillage gave unexpectedly low production yield and was not popular with stakeholders.

Stakeholders are discussing the remediation options at WB4-5 workshop

Stakeholders considered that though stubble and ploughed stubble farming caused slight advantages, they require considerable fallowed strips that diminish the widespread adoption of them at the moment. It is suggested that these technologies would be better alternatives when ground water resources became scarcer and more expensive in near future.

Technology 1: Minimum tillage and stubble mulching

The technologies tested were minimum tillage (MT), stubble fallowing (SF) and ploughed stubble fallowing (PSF), near the settlement of Apak Yayla. They were designed in a strip farming plan on the crop yield of Ekiz bread wheat (*Triticum aestivum* var. Ekiz). For each technology four rows of parcels perpendicular to the dominant wind direction were made of which one is active this year and other fallowed. The following parameters were measured at the times indicated in the table below.

- Sprouting number /m^2 and branching number (in the early and late sprouting period)
- Grain yield, number of grains in ear, weight of 1000 grains, height of plant, harvesting index and # of grains in m^2 (in the harvesting period)

Observations are done on two different locations on each parcel and are averaged later. Unfortunately there were no means to measure physical soil parameters but only crop related parameters (yield related).

RESULTS

Sprouting and branching are used to calculate the density of the wheat plants per m^2. The three technologies resulted in considerable variations in term of sprouting observations. Minimum tillage has the highest sprouting intensity but lower branching number while the ploughed stubble fallowing is optimum for both sprouting intensity and branching number. The inter-annual variation is high.

Grain yield and height of plant is the best for stubble fallowing while the number of grains in ear and weight of 1000 grains do not considerably vary. In terms of harvesting index and number of grains in m^2, minimum tillage and stubble fallowing have clear advantages upon ploughed stubble fallowing (see table below).

Income is based on grain and straw yield, whose amount varies significantly according to the technology applied. From the viewpoint of net economic income, the Stubble farming has clear advantage compared to other technologies (Table below) with a net income of %44. The other two technologies are close to each other.

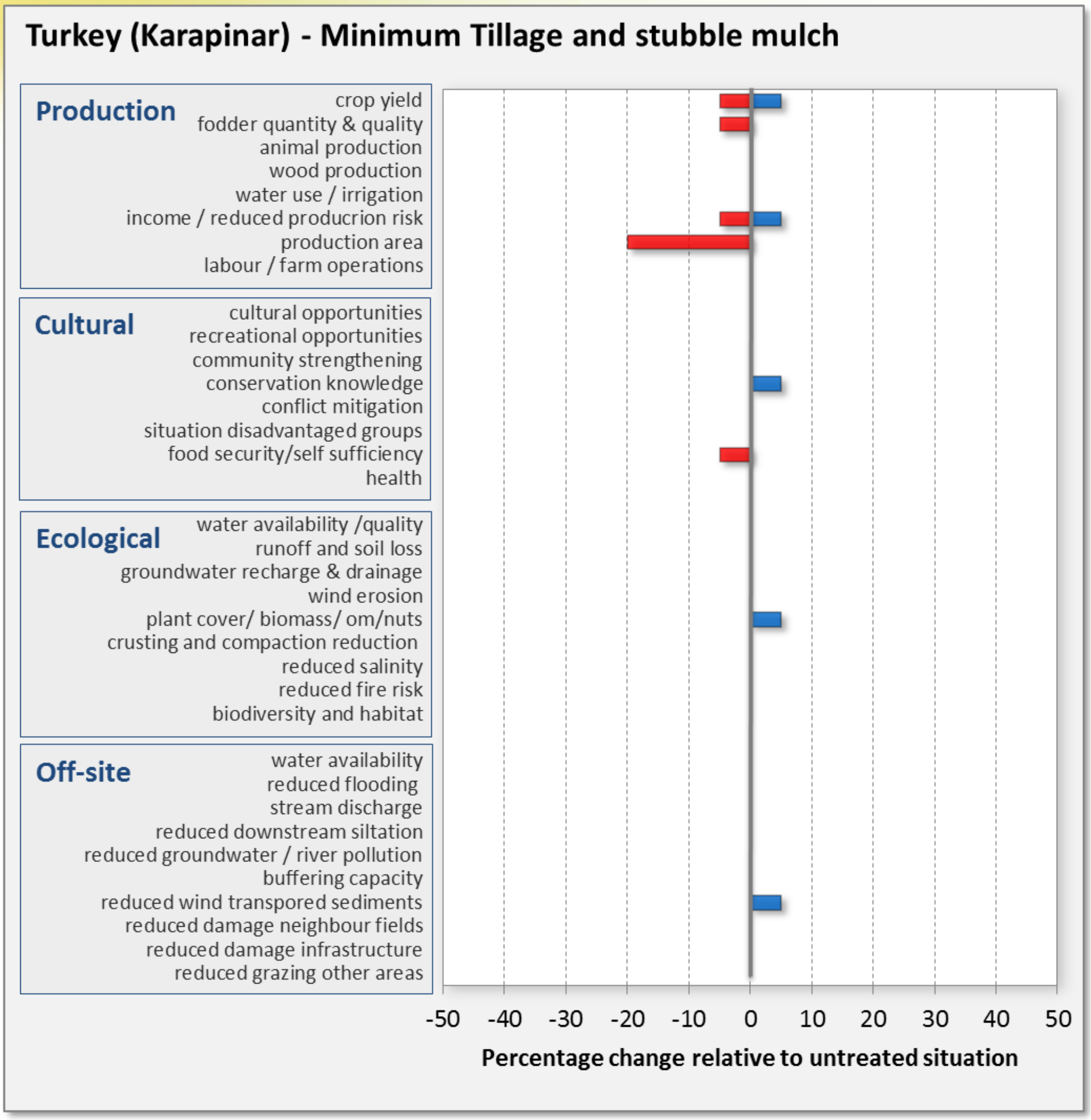
Profuct	2009				2010			
	Yield (kg/da)	Quantity (kg)	Unit price (TL/kg)	Income	Yield (kg/da)	Quantity (kg)	Unit price (TL/kg)	Income
wheat (minimum tillage)	449	512	0.5	256	376	429	0.65	279
wheat (stubble farming)	518	590	0.5	295	562	641	0.65	417
wheat (ploughed stubble farming)	464	529	0.5	265	422	481	0.65	313
Straw (minimum tillage)	965	1100	0.1	110	537	612	0.2	122
Straw (stubble farming)	1053	1200	0.1	120	787	897	0.2	179
Straw (ploughed stubble farming)	1009	1150	0.1	115	591	674	0.2	135
TOTAL INCOME				**1161**				**1445**

In terms of wind erosion, it was observed that the stubble farming and minimum tillage have less visual wind erosion than the ploughed parcels.There are however no measurements for this.

Evaluation

The results were evaluated from a production, socio-cultural and economic point of view. The bars express the estimated or measured percentage of change with respect to the reference situation. This change can be positive (blue) or negative (red). Note that this evaluation is based on the experiments, on the long term experience of the coordinating team in this area and on consultations with the farmers.

Both treatments are evaluated at the same time as they are one large experiment.



Stakeholders are passively involved in the division of the area into technology parcels and the ploughing and sowing operations as observers. The presumed efficiency and expected results of technologies applied in the field were discussed. The owner of the experimental field executed the agricultural activities himself (ploughing, fertilising, etc.) throughout the season.

Stakeholders generally approve the effectiveness of the technologies tested. The yileds are comparable although slightly lower. However the treatment includes a fallow period which for the irrigated areas is not present. Thus land is taken out of production which is considered very negative. This is not compensated by the net gain in income of the treatment because of lower labour and operational costs. This will be different for each farmer, depending on the degree of mechanization. The end result is therefore that the technology is not readily accepted because the benefits are not sufficiently clear cut. This may change if irrigating with groundwater becomes too costly. The experiment shows that rainfed agriculture is possible in principle while having a positive effect on wind erosion (at least visually).

Overview of scenarios

The PESERA baseline scenario run shows very low erosion rates across the entire study site area (below 0.5 ton/ha). The biomass production varies with land use, where arable land has low values. The 200 m altitude range within the study site does show as landforms in the southwest and north of the area, but this has no noticeable further influence on erosion and biomass production.

Technology Scenario:

Minimum tillage

- Total operation costs under different practices:
  - traditional ploughing 736 TRY/ha (€298)
  - Minimum tillage 736 TRY/ha (€298)
- The above operation costs include renting of equipment to implement each practice
- A harvest index for grains of 45% of total biomass was assumed
- The price of grains is 0.5 TRY/kg (€0.20)

Minimum tillage has mixed effects on biomass production: in about a third of the applicable area it leads to yield increases of 4-8%, in the remaining area it leads to yield reductions of 0-3%. These differences are mostly due to differences in soil type. As the cost of minimum tillage does not differ from traditional ploughing, the effect on net profit is either slightly positive or slightly negative, but under the assumptions made cereal farming is not profitable in either case.

Technology Scenario:
Stubble fallowing

- Total operation costs under different practices:
  - traditional ploughing 736 TL/ha (€298)
  - stubble fallowing 736 TL/ha (€298)
- The above operation costs include renting of equipment to implement each practice
- A harvest index for grains of 45% of total biomass was assumed
- The price of grains is 0.5 TL/kg (€0.20)

Stubble fallowing has an insignificant effect on biomass production. As operational costs are not differe from traditional ploughing, the economic viability of cereal farming is not altered (i.e. net profits rema negative).

Technology Scenario:
Ploughed stubble fallowing

- Total operation costs under different practices:
  - traditional ploughing 736 TL/ha (€298)
  - ploughed stubble fallowing 736 TL/ha (€298)
- The above operation costs include renting of equipment to implement each practice
- A harvest index for grains of 45% of total biomass was assumed
- The price of grains is 0.5 TL/kg (€0.20)

Ploughed stubble fallowing has no effect on biomass production. As operational costs are not different from traditional ploughing, the economic viability of cereal farming is not altered (i.e. net profits remain negative).

Global Scenario:

Minimizing land degradation

The minimizing land degradation scenario selects the technology with the highest mitigating effect on land degradation or none if the baseline situation demonstrates the lowest rate of land degradation. The implementation costs for the total study area are calculated and cost-productivity relations assessed. To facilitate comparison between different study sites, all costs are expressed in Euro.

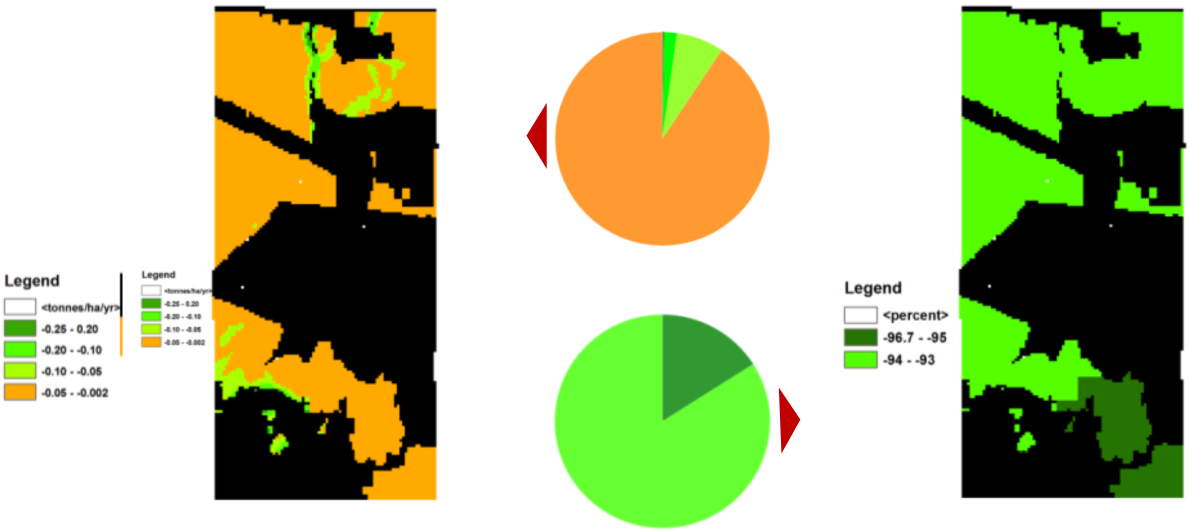
- 0.03 ton soil/ha

€0/ton soil

Scope for reduced erosion

Reduction of erosion (negative values)

Percentage of erosion reduction (negative values)



Biophysical impact: erosion reduction

- Reduction of erosion in 100% of applicable area
- Average absolute erosion reduction: 0.03 tonnes/ha/yr
- Average percent erosion reduction: 94%

Conclusions

- Minimum tillage and stubble fallowing have clear advantages in terms of yield parametres of the Ekiz bread wheat in Karapınar hotspot. Minimum tillage particularly positively effects the sprouting intensity but not the branching number.
- The variations in yield parametres are probably explained in terms of removal of nutrient topsoil by wind erosion. It seems that minimum tillage and stubble fallowing decrease the shear stress of the wind and hence reduce the wind erosion.

- Contrary to vegetative parameters, the harvested product (both for grains and straw) is the maximum in stubble farming followed by ploughed stubble farming.
- Basic obstacles agains the wider application of technologies are considered the lack of specialised machinery and required knowledge for minimum tillage and the decrease of net income due to fallowed parcel each year.
- Wind erosion is the dominant degradation process in Karapinar. According to degradation mapping by experts, arable land experiences light to moderate degrees of land degradation by loss of topsoil through wind erosion.
- The field experiments concentrated on biophysical indicators in a strip cropping set up which is thought to mitigate wind erosion. Minimum tillage rather than no-till was implemented, together with stubble farming and ploughed stubble farming. Hence, experiments concentrated on variants of no-till technology which was prioritised by local stakeholders to address wind erosion problems. The technology models and scenarios show reductions in soil erosion and limited effect on biomass production, although soil erosion reductions were small in absolute terms relative to the scale of erosion levels used in presenting maps. Effects on biomass were positive (4-8%) for minimum tillage in part of the applicability area (one soil type).
- Evaluating the results in a third workshop, stakeholders ranked the three tested technologies in the order stubble fallowing, ploughed stubble fallowing, and minimum tillage. The down-ranking of minimum tillage was a consequence of disappointing yield levels. The most significant concern about all technologies was that it requires fallowing, which local stakeholders regarded as having an important opportunity cost. Participants stressed the need for government subsidies to promote the technologies.
- Global scenarios showed that the technologies can achieve significant relative erosion reductions (94%) across the entire applicability area, despite the fact that erosion levels are already quite low. Yield effects are more limited, with a 6% increase possible on 36% of the applicability area. The average expected yield increase is 34 kg/ha/yr and the average erosion reduction 0.03 ton/ha/yr.
- From an ecological point of view, all technologies are effective to reduce soil erosion. Effects on biomass and yield levels are relatively small and experimental and modelling results do not fully support each other. The main obstacle for adoption of the technologies is their economic viability, especially if conventional ploughing can be implemented without fallowing and the technologies require fallowing. There is little risk in applying the technologies and stakeholders realise that when water becomes scarcer and more expensive in the future, fallowing can become an increasingly viable strategy. Further confirmation of the (economic) effects is necessary before any of the technologies can be recommended. Given that subsidies are said to be required, it would be important to consider the off-site costs and benefits due to wind erosion in the area.

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➜ This project has been funded by the European Commission DG Research-Environment Programme
Unit of Management of Natural Resources
Head of Unit *Pierre Mathy*, Project officer *Maria Yeroyanni*

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See: http://www.desire-his.eu/en/karapinar-turkey for full details of DESIRE research