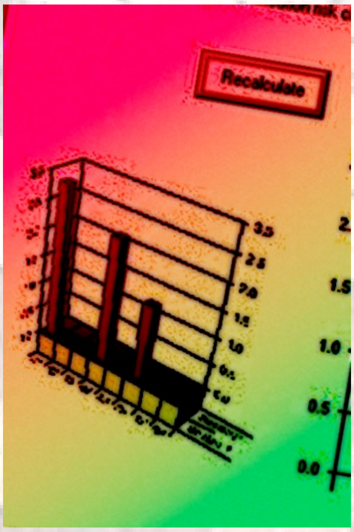
DESIRE REPORT series



Evaluating the desertification indicator system with experimental results

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May 25th 2012

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Deliverable 4.4.1

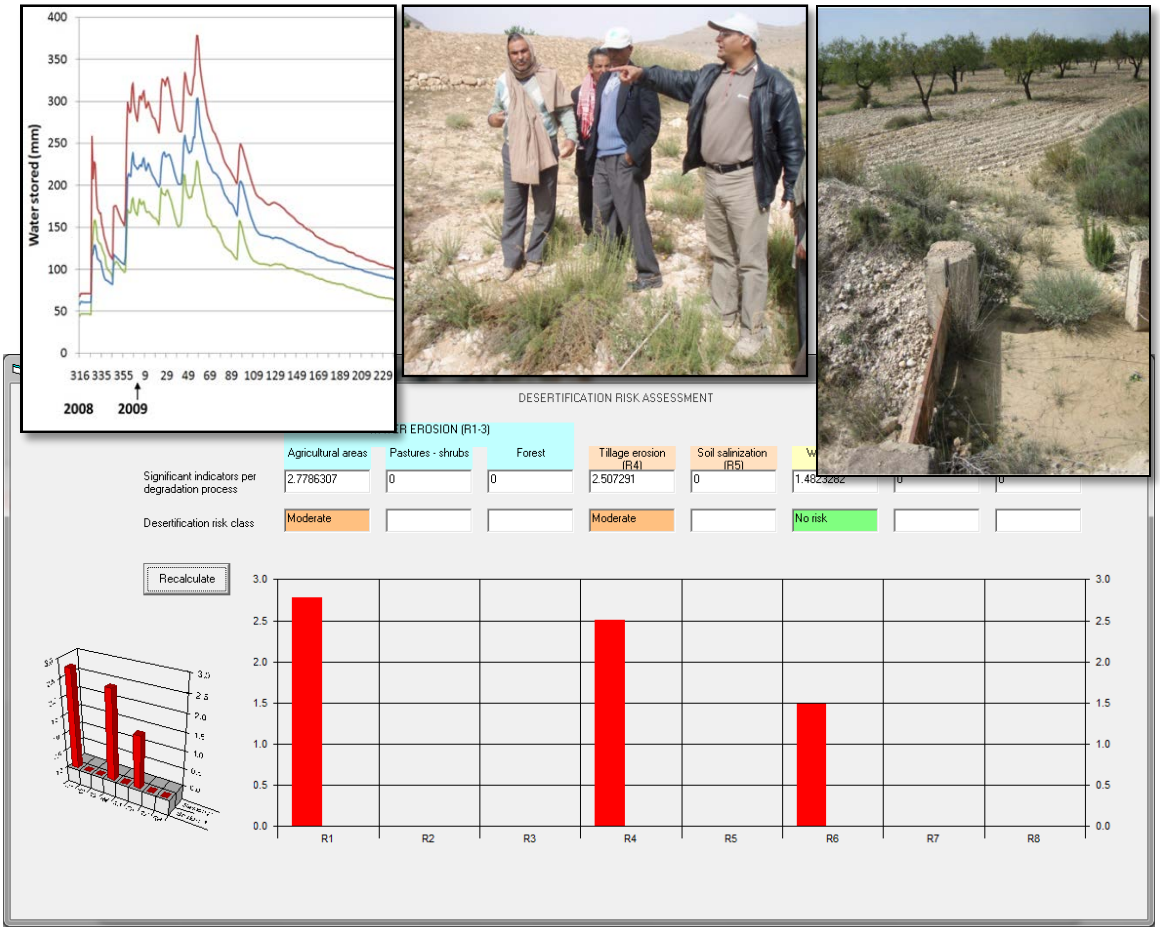
Report number 98
Series: Scientific reports

This report was written in the context of the Desire project
www.desire-project.eu

Deliverable 4.4.1

WB4 – Evaluating the desertification indicator system with experimental results

Results of field experiments



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Contents

Introduction

This report is deliverable 4.4.1 of the DESIRE project and summarizes the work doen in Work Package 4.4.

Indicator systems are widely used in a context of dersertification and under constant development. The rich dataset of DESIRE was used in WB2 to create an indicator system that calculated for the d*esertification index*. The tool is available on the DESIRE HIS website. The desertification index is a dimensionless value derived for a multivariate analysis over all sites that expresses the degree of desertification, divided in:

- water erosion, on agricultural lands, grass lands/shrub lands and forests
- tillage erosion,
- salinization,
- forest fire,
- water stress,
- overgrazing.

The user selects from a large list of variable the classes that are relevant for the specific situation under investigation, selects the desertification process(es) that are under review and gets for each process a desertification risk assessment in no risk, low, moderate and high risk and an index values. The risk is expressed in a dimensionless value, that has no direct physical meaning but expresses a degree of desertification risk. This is then classified by the system as "no risk" ,"low, "moderate", "high" and "very high".

By calculating the risk for each site of the reference situation and the risk for an implemented technology, it can be evaluated if this technology has the effect of lowering the risk as intended. There is some interpretation involved to fit a particular situation in the variable classes of the system. The tool is very versatile, variables that are unknown for a site can be excluded, so it can be adapted to the available data of a site.

The aim of this WP is simply to use the experimental results as reported in deliverable 4.3.1 in the desertification risk system, identify bottlenecks and give advice for future development of the system.

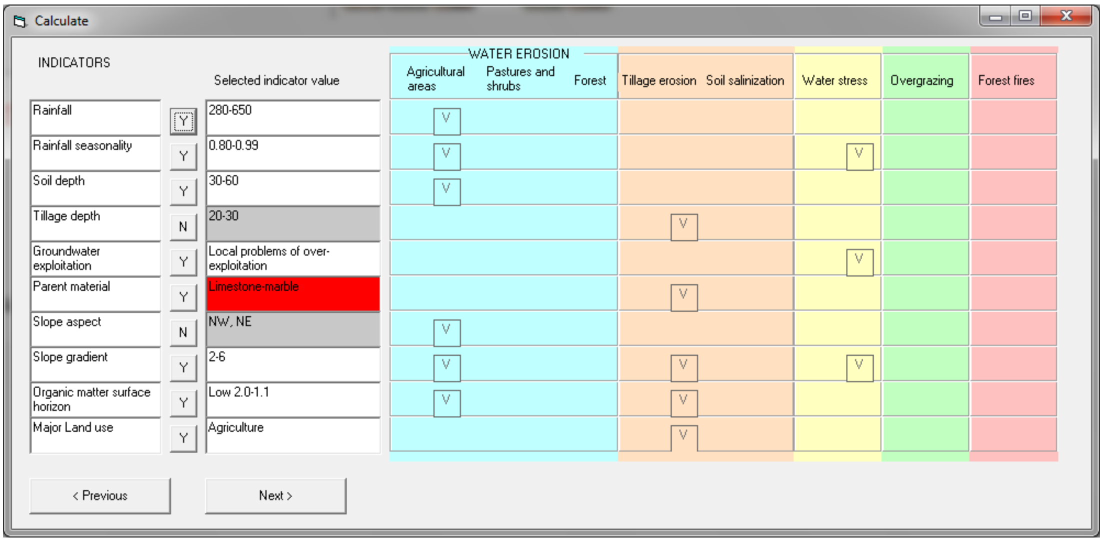
It is important to realize that the tool is used here out of context: it is not meant to evaluate individual experiments on a field/plot scale as it is based on variables across all sites and also partly based on more regional variables that are not affected at an experimental scale.

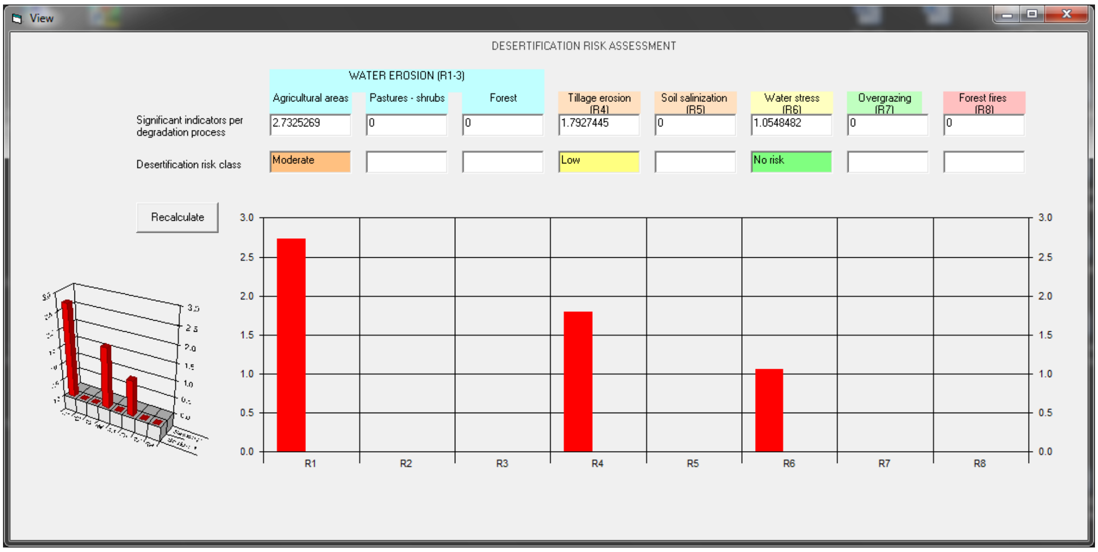
Methodology

The methodology is simple: for each site the tool is used to calculate the desertification index of the reference situation. Subsequently all experiments on a site are included and the change of desertification index is noted. This is repeated for all sites. The figures below give an input screen and the result from one of the Spanish experiments. The change in desertification risk is then compared against the overall results as documented in 4.3.1.

This is not a direct comparison, because the tool is not meant to do that. For instance water stress risk can occur on a site because of a range of circumstances related to climate, soil, vegetation, farming practices and so on. A direct comparison against a measured soil moisture change on a certain depth in the soil is useless because many more factors are involved. So a lowering of water stress risk because of a technology and a change in moisture content cannot be compared, even relatively. The same holds true for all other processes/risks. Therefore the results are compared in a more general sense.

The figure below show one of the input screens and an output screen of the desertification risk tool. It is more extensively explained in the WB2 deliverables.





Site results

Site 1 – Spain

Introduction

In the Guadalentin basin in south-eastern Spain, land degradation is considered severe due to a combination of several factors. The semi-arid climate has dry summers followed by intense autumn rainfall, while there is a steep topography and fragile soils. Desertification takes the form of soil erosion and drought. Moreover, considerable land use changes have taken place over the last centuries, which is an important driving force for further degradation in the area. Different conservation techniques used are: water harvesting with irrigation by captured runoff water, minimum tillage, mulch and green manure.

The most dominant soil types in the Torrealvilla study area are Regosols, Fluvisols, Calcisols, Gypsisols and Leptosols (FAO, 2006). The experimental plots are located on Calcisols and Regosols under relatively gentle to moderate slopes between 5 and 15 %. The climate is semi-arid with a mean annual rainfall around 300 mm. Droughts, centered in summer commonly last for more than 4-5 months. Annual potential evapotranspiration rates larger than 1000 mm are common.

Desertification indices

The index was calculated for **water erosion**, **tillage erosion** and **water stress**. A single set of values is selected and the conservation techniques are implemented as good as possible, selecting a combination of variables related to the technologies. A distinction is made for Almonds that grows as separated bushes with bare soil in between, and cereals which have a denser seasonal cover. The almonds grow on terraces, while the cereals are on gently sloping terrain.

Generally water erosion is identified as a moderate risk followed by tillage erosion (moderate) and water stress (no risk).

Almonds and water harvesting: water harvesting cannot really be implemented except as runoff control which slightly decreases the water erosion, also the fields are on terraced land. Water stress is not identified as a problem. The experiment showed that water harvesting was a success in terms of yield increase although the effect on desertification was not very direct. From that point of view the system is correct.

Almonds and reduced tillage: the system shows a clear effect and water and tillage erosion reduce to low risk (in line with reality). Note that minimum tillage ignores the ploughing setting, so tillage operations have to be set to “no ploughing”.

Almonds and green manure (green cover) is parameterized as sustainable farming “inducing cover” and soil erosion control measures with an increase of cover to “adequate 75%”. Oddly enough this does *not* influence water erosion which is comparable to the unmitigated situation. This is not according to reality.

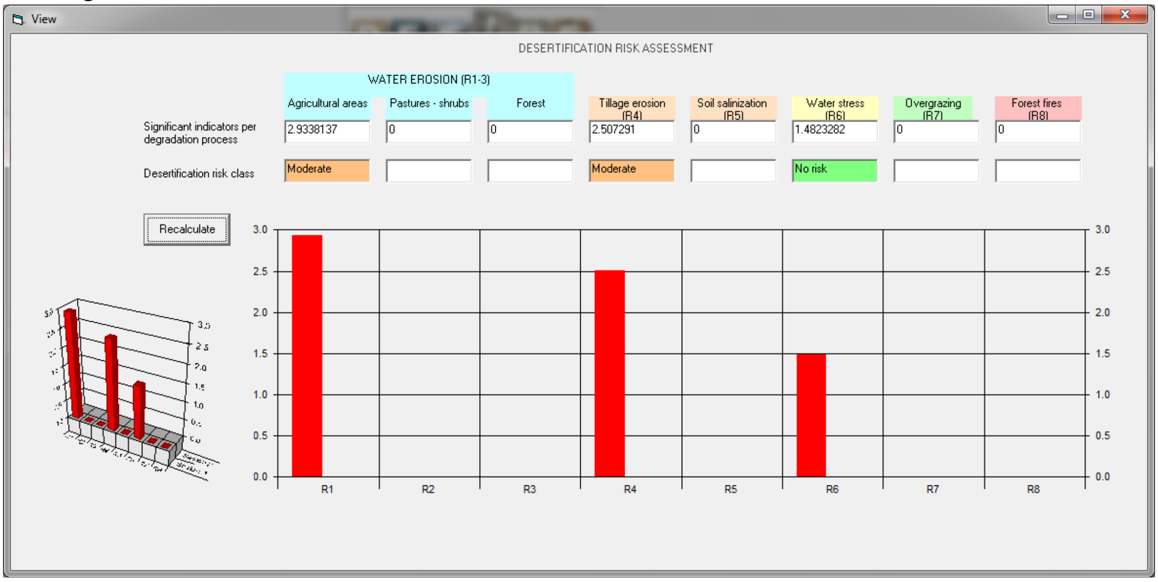
Cereals and minimum tillage: similar to Almonds and minimumtillage. The plant cover does not sem to have an effect on the water erosion: a cover of < 25% or >75% does not generate a difference.

Conclusions

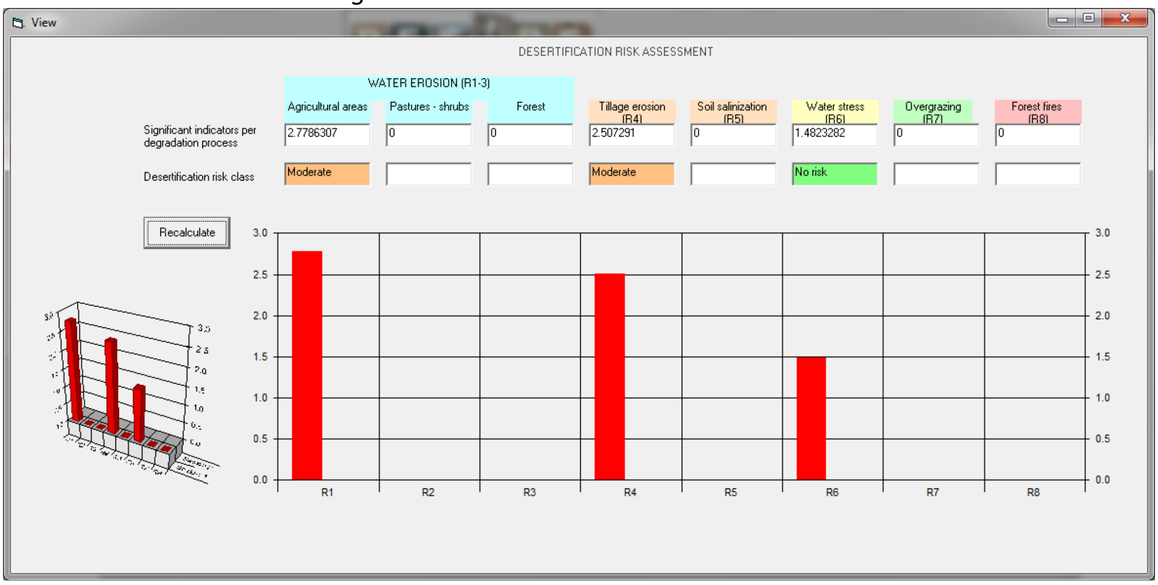
The system does not permit very well to include the conservation measures implemented in Spain. Clear reductions in runoff measured for minimum tillage and green cover under Almonds were only shown as a slight decrease in risk. The overall picture is correct but the effect of the technologies seems minimal. Water stress is not identified while this is generally a problem in the area. Interestingly tillage erosion is seen as a moderate hazard which could be an indication for further research.

Certain variables are not linked: minimum tillage can be selected with ploughing as a tillage operation which will then ignore minimum tillage. Al soil cover does not sem to have an effect n water erosion.

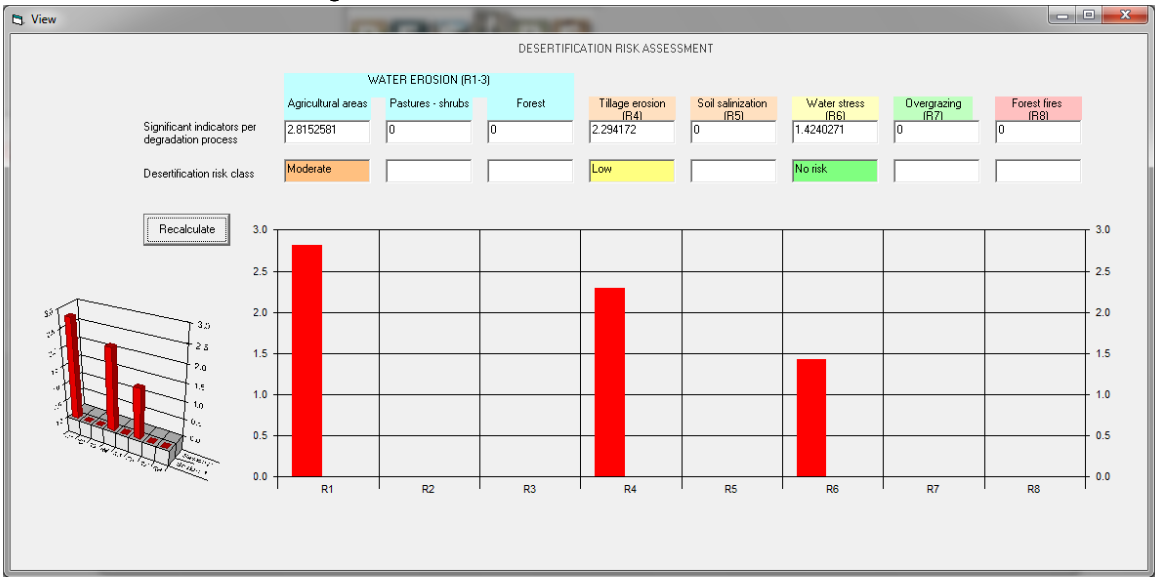
Unmitigated situation Almonds



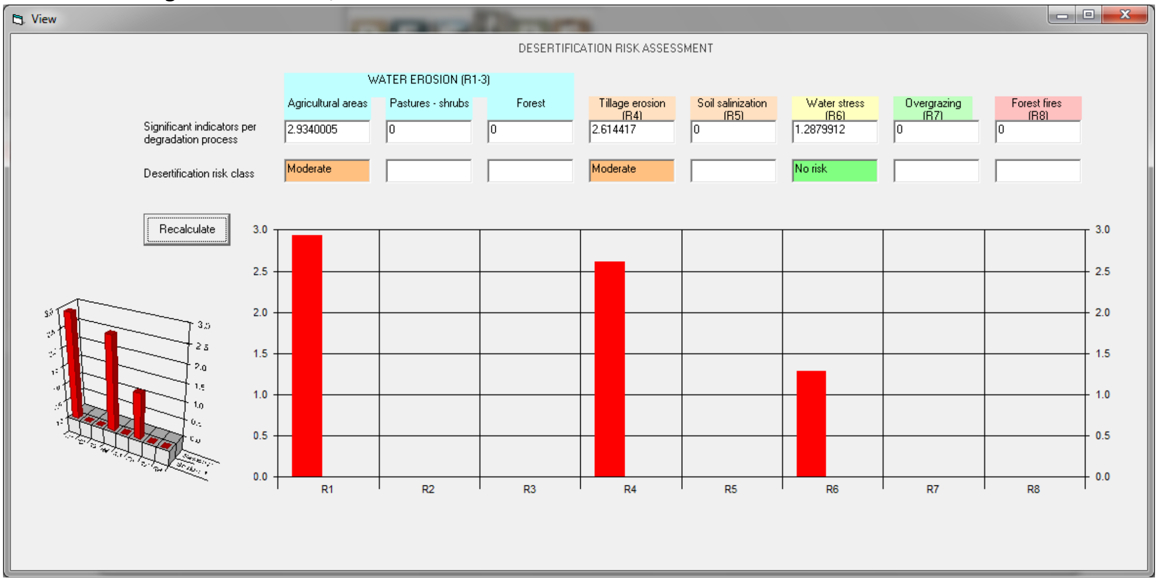
Almonds and water harvesting



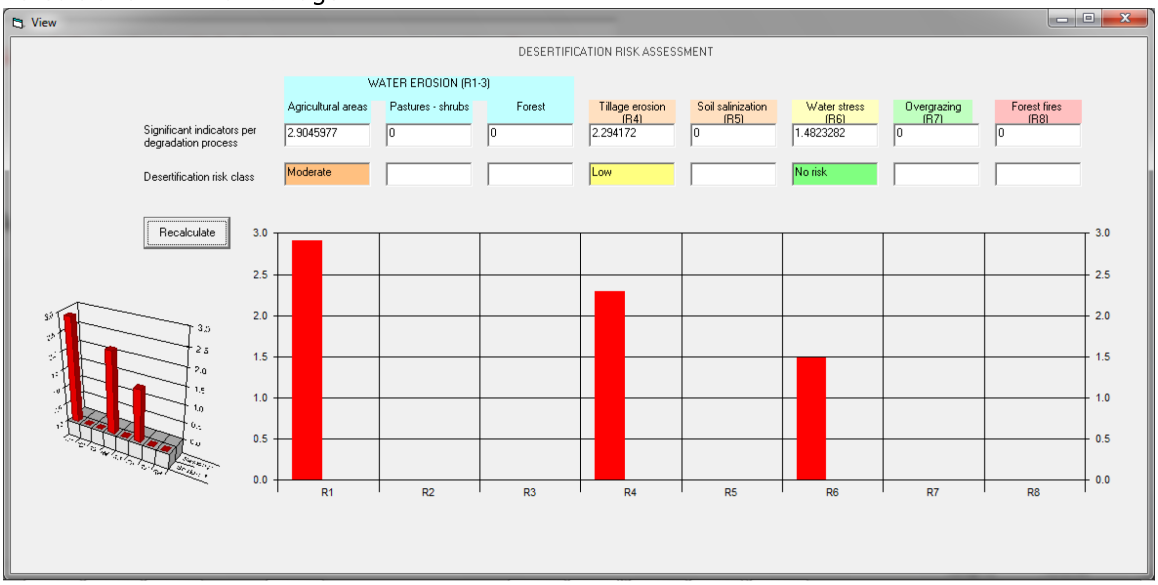
Almonds and minimum tillage



Almonds and green manure/cover



Cereals and minimum tillage



Site 2 – Portugal

Introduction

Like many Mediterranean countries Portugal suffers from forest fire due to its dry and hot climate. The problem is not only degradation of forest and the emission of carbon dioxide to the atmosphere but it also increases soil losses and pollution of water and air. The Mação Region in Portugal suffered massive fires in 2003 and 2005 affecting more than 70% of the municipality area. To protect the forest from wild fire strip network is constructed. The Vale Torto area near Góis in Portugal was burned by several fires in the 1970s and the early 1980s. Similarly the Camelo catchment near Góis also suffers from forest fire with the recent fire taking place in July 2008. Experiments included strip corridors (Macao) and prescribed burning (Vale Torto).

The area has shallow Cambisols (< 30 cm deep) over metamorphic shists and steep slopes. The main vegetation is pine forest, Eucalypt and shrubs, but fire destroys this and decreases the vegetation cover. The climate shows a strong seasonality despite the overall high precipitation (600-1000 mm per year) with dry summers. The landscape has steep slopes and a deeply incised drainage system.

Desertification indices

The index was calculated for **water erosion**, **overgrazing**, **water stress** and **fire risk**. The values depend on the selection for intact forest or for a burned area, which affects mainly water erosion and overgrazing. On the next page the result of three calculations are shown: intact forest, heavily burned forest and forest with fire protection measures. The differences between the areas are not sufficient to distinguish them in the desertification index system.

Oddly enough the desertification index scores highest for overgrazing, and fire risk, for which the area is known, scores only as low risk. The fire risk depends on land use intensity which is difficult to estimate: if tourism is counted (which is one of the causes of forest fire) and the land use intensity is increased from low to high, the fire risk increases also from 1.49 to 1.65.

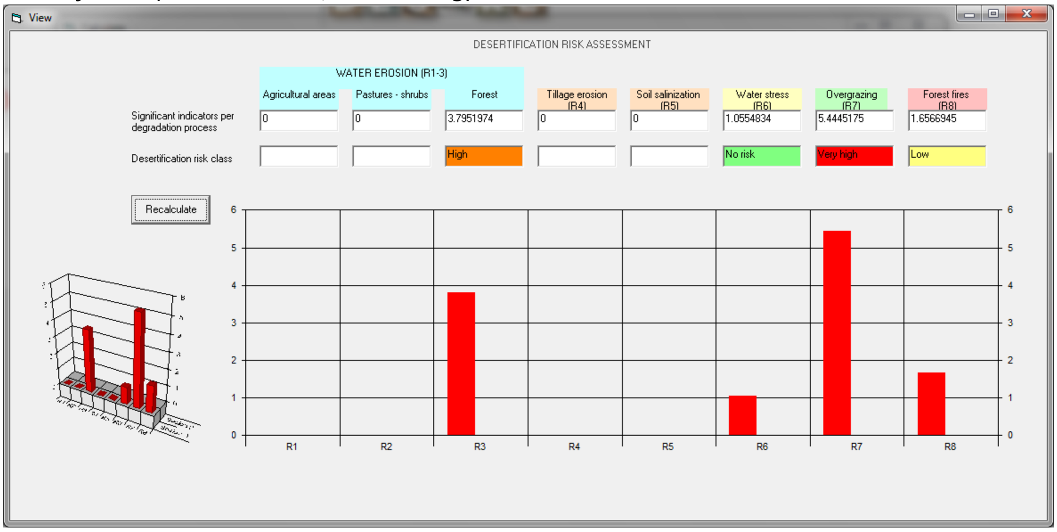
Water erosion and overgrazing give the highest risk factors, respectively 3.8 and 5.4 for an intact forest with a cover of 0.5-0.75. The fire risk is low: 1.7 and there is no water stress. After a forest fire with a low cover and high percentage of forest fire these values change to 4.5 for water erosion and 4.7 for overgrazing, presumably because there is less vegetation to graze upon.

The fire risk is not affected by the burning. This may indicate a false effect: in reality a forest fire would decrease the fuel load available and greatly decrease the risk. This is in fact the purpose one of prescribed burning, which is one of the control measures tested in the project. Fire protection also hardly affects fire risk, the index decreases from 1.65 to 1.48, both in the low risk zone.

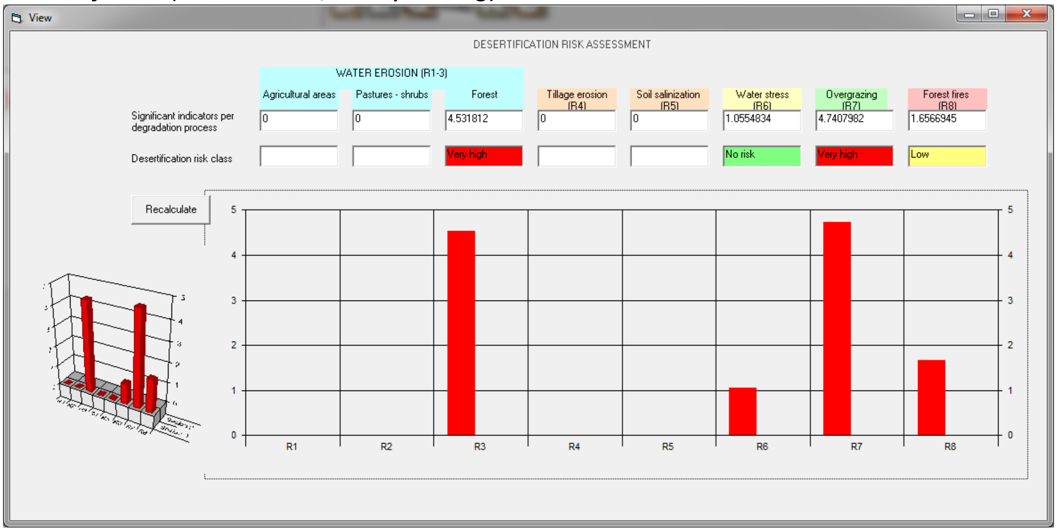
Conclusions

The desertification index gives a correct assessment that it shows water erosion as clear a risk in this area with shallow soils and steep slopes, as is also one of the objectives in the DESIRE project. Howver the erosion risk is also high for the natural situation of intact forest which is less clear. Overgrazing is also a risk in these fragile ecosystems which is not taking place yet because of the low animal density. Forest fire risk is not so well indicated, the index does not sem to e affected by variables that are related to forest fire for unclear reasons.

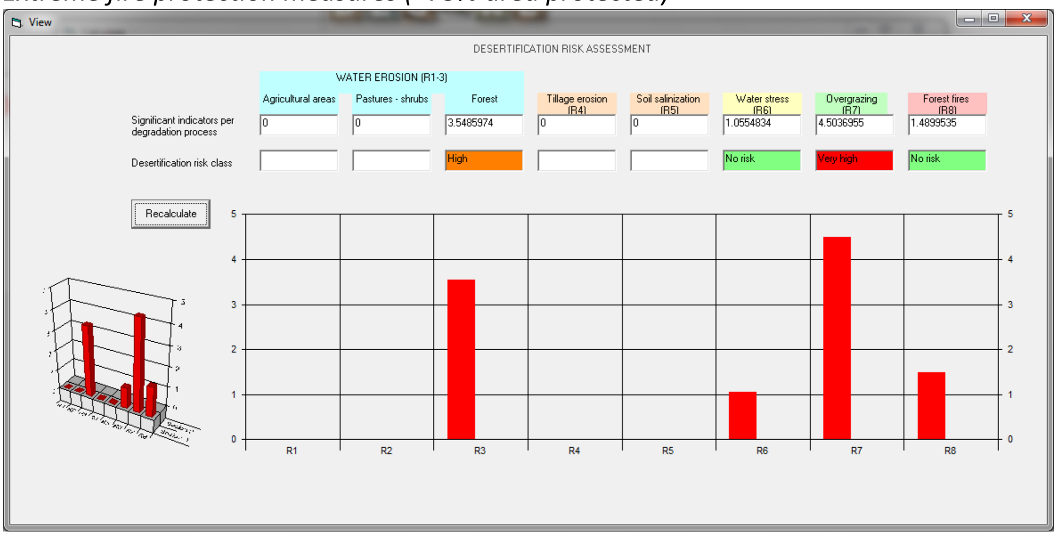
Intact forest (50-75% cover, no burning):



Burned forest (< 10% cover, heavy buring):



Extreme fire protection measures (>75% area protected)



Site 4 – Greece, Crete

Introduction

The eastern and central part of the Greek island Crete is suffering from land degradation problems, while the rest of the island is highly sensitive to desertification. Soil erosion due to surface runoff and tillage operations, collapse of terraces, overgrazing, salinization of lowlands, and overexploitation of ground water are the major processes of land degradation in the area. A lot of forested areas were converted into cultivated land in the last century. Overgrazing and fires further destroyed the natural vegetation cover and prevented its regeneration.

Olive groves are an important form of land use in the area, but have various degrees of due to the different land management practices. Farmers perceive an herb cover as a competition for water for the Olive trees and keep the field clean and bare below the trees. A minimum tillage experiment with and without herbicides was carried out to see if it is possible to maintain a soil cover, restore the natural soil structure, promote infiltration and reduce runoff and helps in minimizing soil losses. Overgrazing on the shallow stony soil decreases cover and destroys soil structure, and therefore promotes runoff and erosion. A grazing control experiment was done in this area.

The Olive area is moderately sloping land (up to 17%) with relatively deep soil (55-65cm). The overgrazed area has very shallow soils with frequent outcrops.

Desertification indices

Both areas are separately parameterized with **water erosion** and **tillage erosion** for the Olive field and **water erosion** and **overgrazing** for the rangeland plot.

Olives and minimum tillage: the overall unmitigated risk is moderate for water and tillage erosion on sloping Olive fields without soil cover and erosion control measures, and tillage operation to keep the area between the trees bare. Minimum tillage decreases the water erosion slightly and tillage erosion more (to low risk). The main factor here is setting the tillage operations from ploughing to none. Setting minimum tillage or no-tillage has no effect.

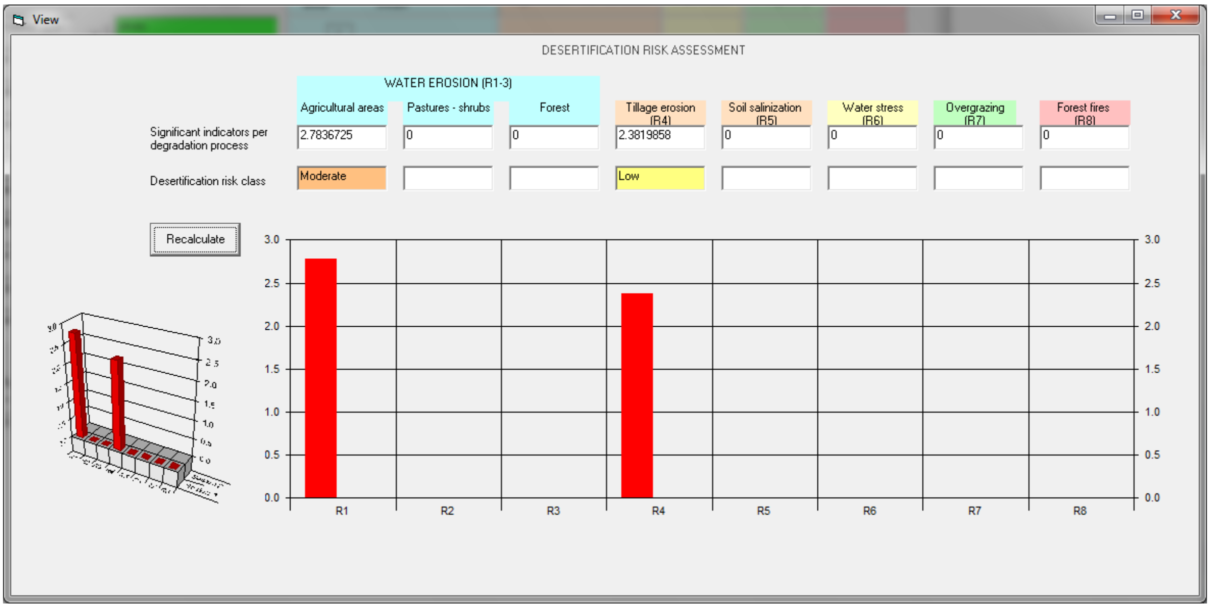
Grazing lands seem to have a low risk for water erosion and low risk for overgrazing. Increasing the vegetation cover by fencing the rangeland will correctly decrease both to a no risk level, but the change is not very large.

Conclusions

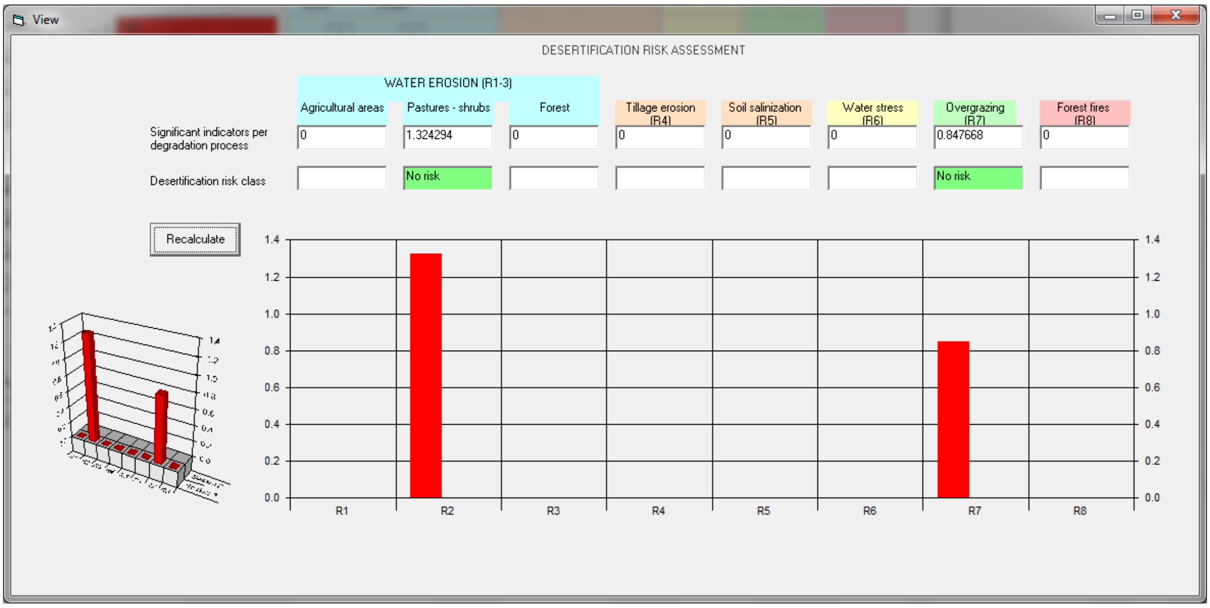
For Crete he observed changes are in line with the experimental results and are therefore correctly indicated, but not as pronounced as measured (up to a 50% reduction in runoff and erosion was seen). Also the over grazing risk reduction is correctly identified and in line with the expriments.

The system exhibits strange behavior that the setting of minimum tillage or no tillage has no effect on water erosion, but setting tillage operations form ploughing to none has.

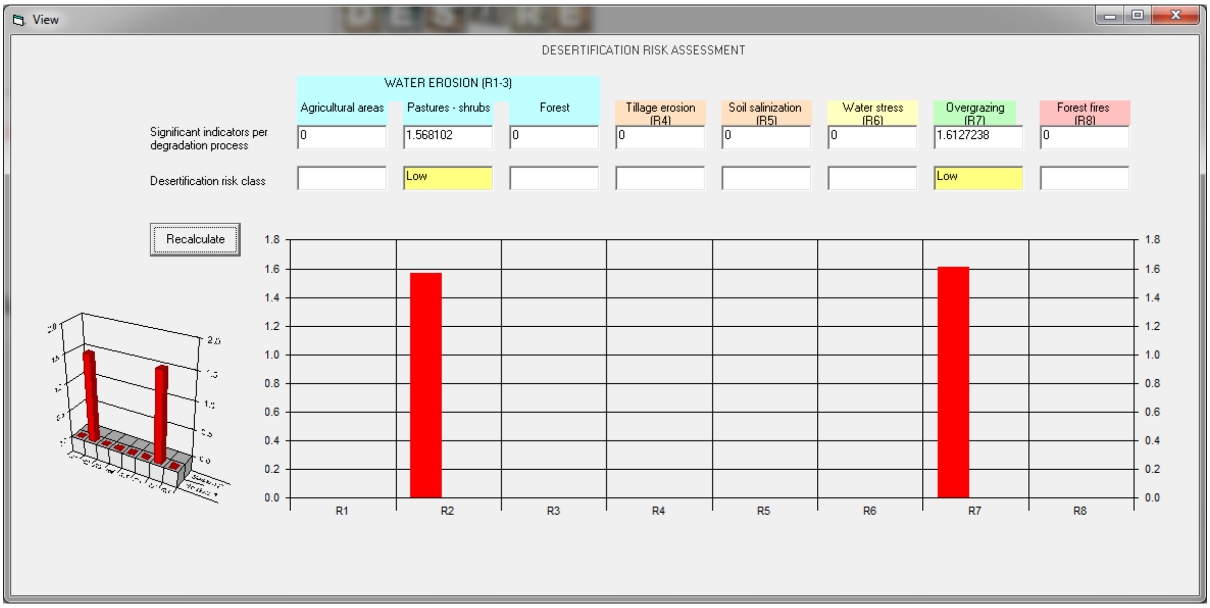
Olives unmitigated



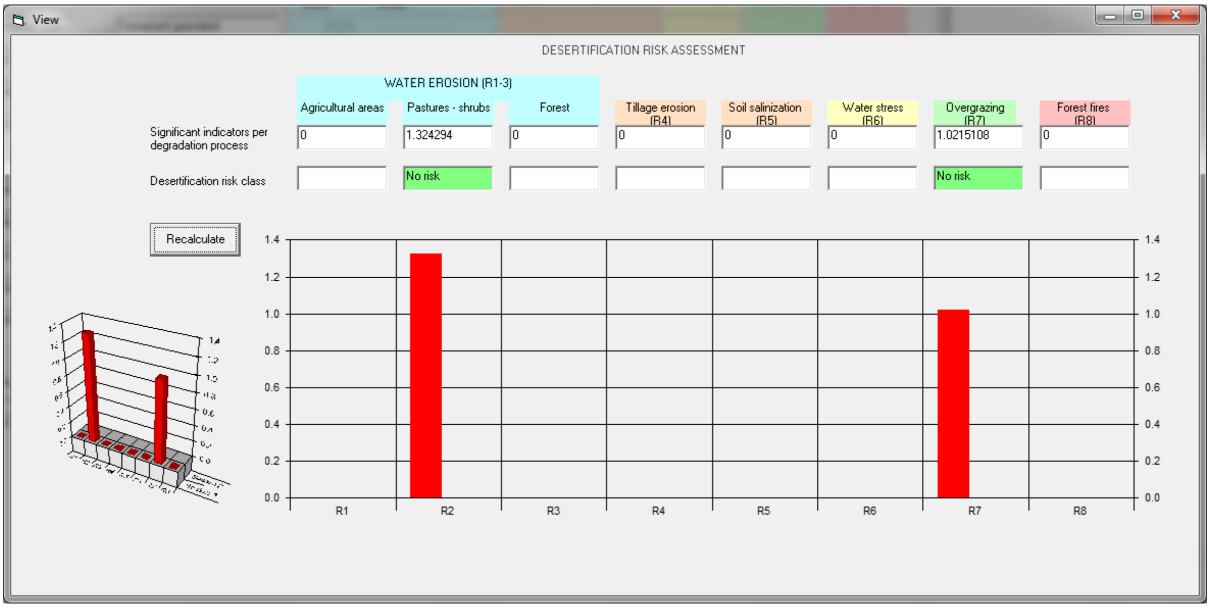
Olives with minimum tillage



Grazing unmitigated



Grazing with rangeland resting



Site 5 – Greece, Nestos

Introduction

The coastal region of the East Nestos River Delta (Maggana, northern Greece) has limited freshwater supplies although irrigation is exceptionally intensive. Studies show that there is intrusion of seawater into the coastal aquifer. The shallow brackish groundwater is in use for irrigation since the last 40-50 years, which has caused severe salinization of the soil. Apart from the chemical problems for crop growth, salinization affects the permeability of soil and causes infiltration problems, because sodium in the groundwater replaces calcium and magnesium adsorbed on the soil clays and causes dispersion of soil particles: a breakdown of aggregates and natural soils structure. Also deeper in the soil this has caused compacted layers to form. Salinization is very difficult to reverse, and the only possible solution in the area lies in flushing the soil with fresh water from the river systems or fresh groundwater further inland. This experiment tests the soil degradation can be reversed on a field scale and if this results in better crop performance.

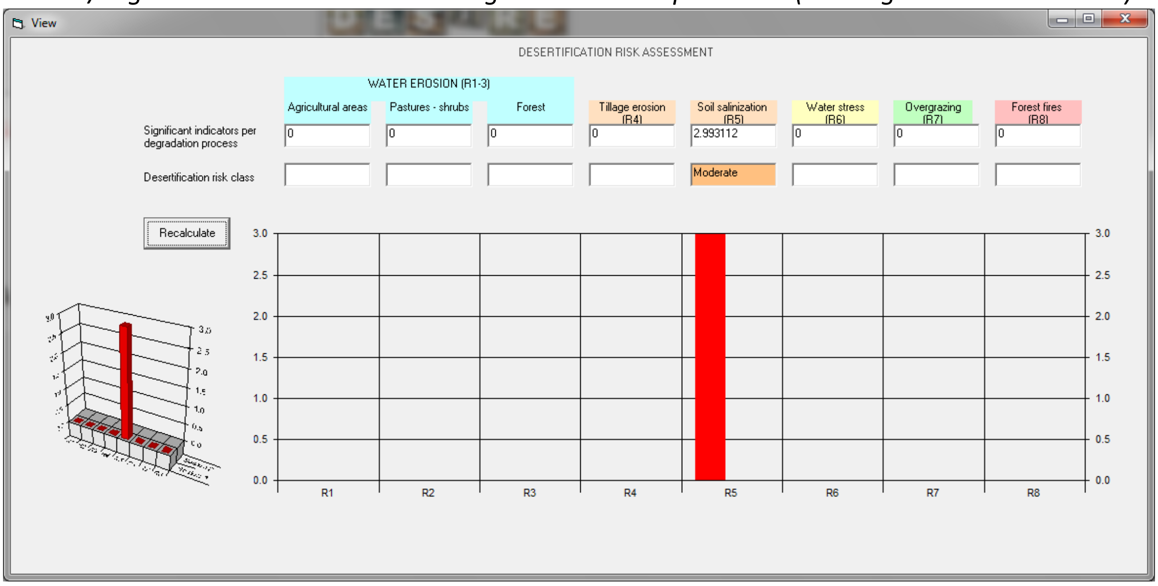
Desertification indices

The desertification indicator in this area is salinization. None of the others apply. When filling in the area characteristics the salinization aspect turns out to be moderate/high (2.99). This is mainly due to the factor "exploitation of the groundwater". When this is high (over-exploitation) the salinization risk is medium to high, when there is no exploitation this is lowers the risk to "no risk". This factor and the factor "population density" seem to be the only ones correlated to salinization risk in the system. This means that the technology (fresh water irrigation) gives a lowering of the salinization risk because the assumption is that this will decrease groundwater exploitation and even groundwater recharge (risk index = 0.75).

Conclusions

The indicator system correctly identifies the area as having a high salinization risk but this depends only on one factor: groundwater exploitation. Thus different technologies that influence this factor will have an immediate effect, others (such as applying chemicals) will not have an effect.

Cereals/vegetables salinization risk with groundwater exploitation (unmitigated circumstances)



Site 6 – Turkey, Karapinar

Introduction

The Karapınar area is the most arid part of Anatolia in Turkey, which suffers from wind erosion due to unfavorable soil and climatic conditions. Also the area knows intensive use of ground water resources for irrigation. Earlier ground water well measurement showed that annual drop reaches 8-10 m. Farmers mostly prefer cereals, maize and sugar beet as irrigated crop types. Ploughing often results in fine particles that are removed by the wind. Direct drilling has already been introduced as an alternative. An experiment was carried out to test the effect of minimum tillage and stubble on wheat (Ekiz bread wheat) without irrigation. Sediment moved by wind erosion itself is very difficult to measure so the experiment concentrated on the suitability of these tillage forms.

Desertification indices

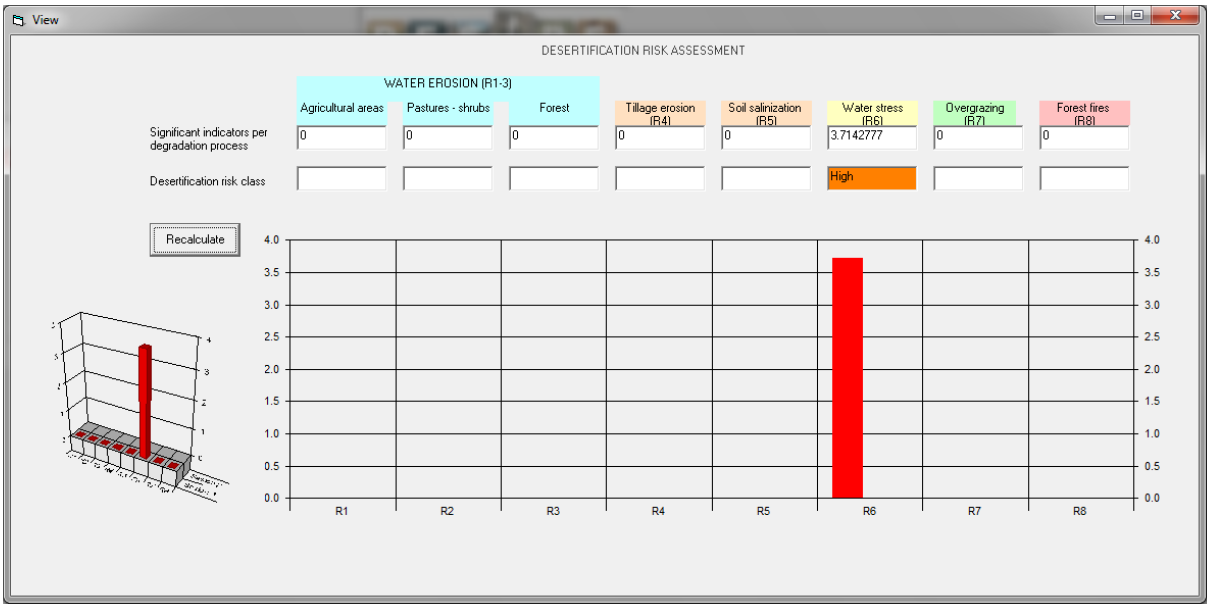
The area is main;ly subject to wind erosion, which is not a factor in the indicator system. The desertification index for water stress is evaluated. This is because the crops are irrigated and heavy (over) exploitation of groundwater is common. Together with a low rainfall and marked dry season this results in a high risk of water stress, in accordance with the experiments.

However the use of minimum tillage has no effect on water stress so the technology cannot be further evaluated. The experiment showed that it is possible to have a reasonable yield with minimum tillage without irrigation. If we assume this would cause a gradual change in groundwater exploitation until there is only local overexploitation, the water stress risk will be reduced to moderate.

Conclusions

Wind erosion cannot be evaluated with the system. Water stress, although correctly seen as having a high risk, is not influenced by tillage practices.If the minimum tillage causes the crop to have acceptable yield with rainfall only without the need for groundwater irrigation, this would decrease the water stress risk to moderate.

Wheat production under circumstances of groundwater exploitation



Site 7 – Turkey, Eskeshir

Introduction

The hill slope areas near Eskisehir suffer from soil erosion. The area is semi -arid, soils are shallow, stony and organic matter content is low. Land use is rainfed wheat with occasional fallow periods. Slopes range from 10 to 20%. Late spring and early summer rainfalls are particularly erosive (400 mm annual rainfall with a marked dry season). Experiments were carried out that interrupt the runoff and help increase infiltration and thereby increasing soil moisture storage (wicker fences as sediment traps and contour ploughing). The overall objective is to decrease surface runoff and to reduce soil losses. Land abandonment in the area occurs because of urban migration.

Desertification indices

Desertification expresses itself as **water erosion** and possibly **tillage erosion.** Both get a rating of moderate with a rating of 2.82 and 2.91 respectively. The measures are difficult to implement. The wicker fences will cause terraces to be formed gradually. Implementing terraces only decreased the water erosion risk only slightly to 2.64.

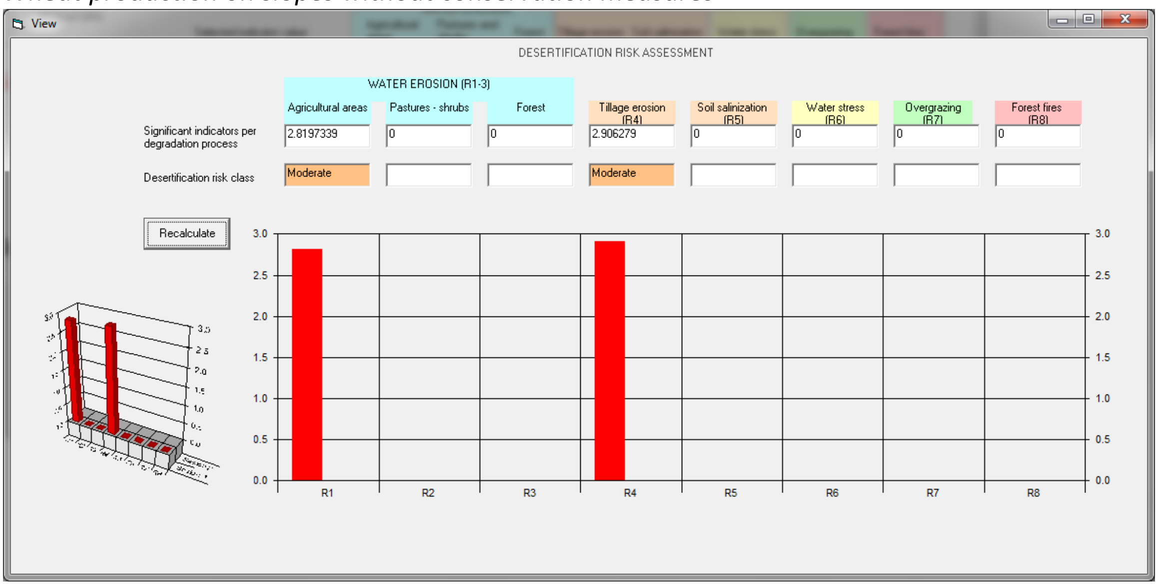
Implementing a maximum interruption of runoff as a result of contour ploughing decreases water erosion risk to 2.66.

Implementing both terraces and contour ploughing decreases the erosion risk to low: 2.48.

Conclusions

The general moderate water erosion risk is correct for the area where erosion is present but not excessive. The precise experimental measures (contour ploughing and wicker fences) could not be implemented but when translated to interruption of runoff and terracing give a small result. In reality the result was observed ones where the treated field had no erosion while the adjacent fuield did have erosion. Decreased runoff also expressed itself as a higher infiltration and increased water availability. This link is not made in the indicator system (as it isbuild on correlation, not on process relations).

Wheat production on slopes without conservation measures



Site 8 – Morocco

Introduction

The North West of Morocco has areas with extensive gullying of the agricultural lands. High pressure agriculture and overgrazing, combined with occasional heavy rainfall, causes severe land degradation. An additional problem is sedimentation in the drink water reservoirs downstream. For farmers in the area, annual crops for food production and livestock for immediate income is vital. The area characterized by a strong variation in seasonal rainfall from year to year. Ploughing is done at the first rains after September and with sufficient rainfall there will be a moderate harvest in February (mostly Wheat and Barley). If the crop fails it is used for fodder. For farmers in the area, annual rainfed crops for food production and livestock for immediate income is vital. There are no additional water sources and water conservation measures could help in this situation.

Desertification indices

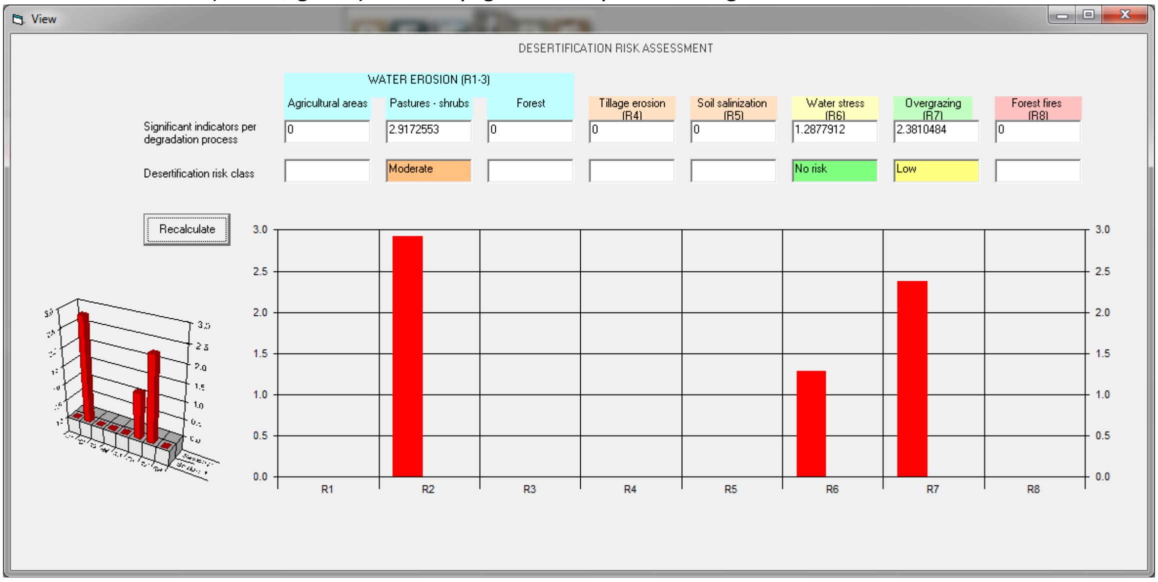
The first area is abandoned and has heavy gully incision but analysis with high resolution remote sensing of gully change actually sows that the current erosion is not so high. This is well reflected in the erosion risk index of 2.92 (moderate risk). Vegetation cover is annual herbs and grasses. Water stress is seen as no risk (1.29) and there is a low risk of over grazing (2.38). The technique of gully stabilization with planting of *Atriplex* bushes and fencing cannot be tested directly but the added effect of an increase in cover and biomass can be simulated, while there is an assumed moderately effective capturing of runoff. Implementing this leads to a water erosion risk of 2.49 (low risk). Overgrazing reduces to low risk (1.62).

The second technique is minimum tillage on a rainfed cereal producing field on stony shallow soils. The slope angle is the same (20%). Under unmitigated circumstances the water erosion risk is moderate (2.78), a low overgrazing risk (2.38) and no water stress risk (1.29). Applying minimum tillage slightly lowers the erosion risk (still moderate: 2.56) and lowers also the water stress (1.17) and overgrazing risk (2.12).

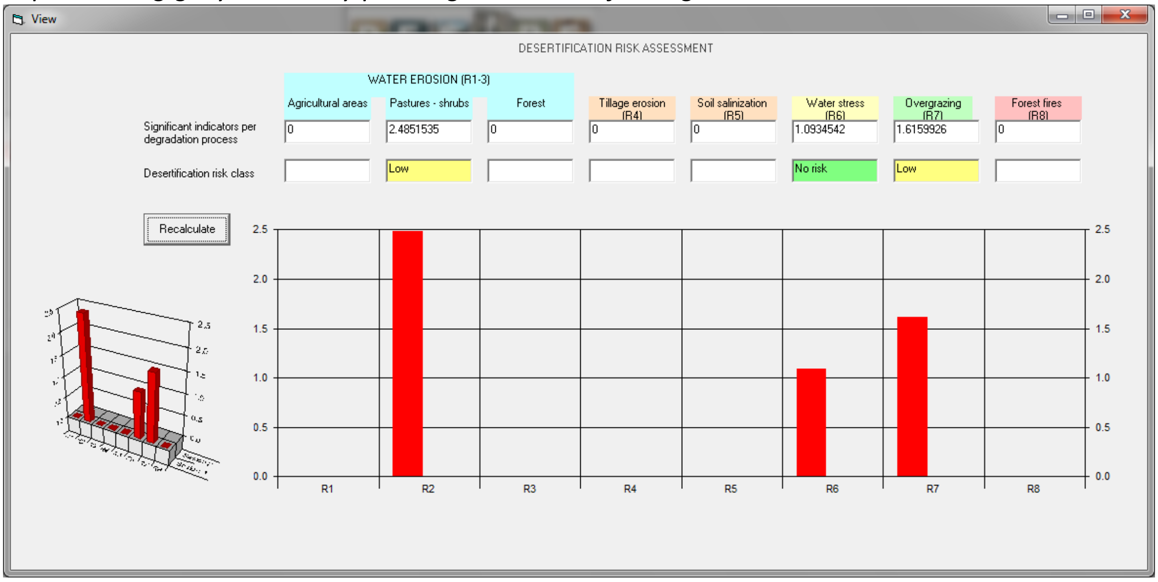
Conclusions

The system correctly classifies the risk levels of water erosion and overgrazing, but seems to underestimate the water stress risk (farmers have a difficult time gaining sufficient yield from rainfed agriculture in the area). The results are in line with the experimental results. Also when implementing the techniques the results are adequate although less pronounced than the experimental results. The techniques have to be translated to a change in primary variables first for this to happen (e.g. fencing means an increase in cover).

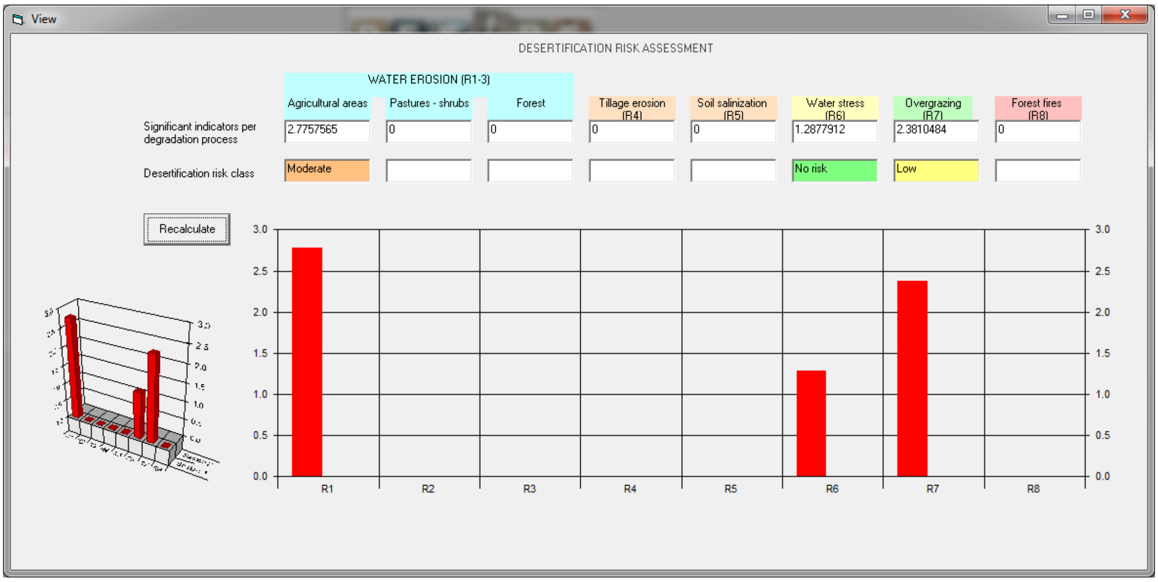
Abandoned land (herbs/grass) on steep gullied slopes unmitigated



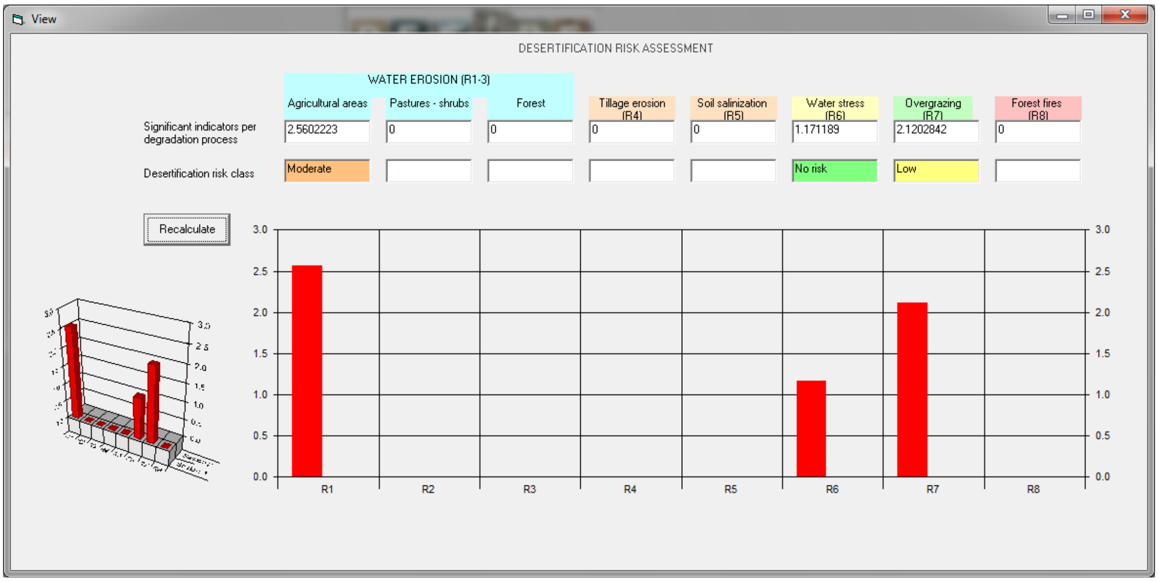
Implementing gully control by planting bushes and fencing



Cereals on steep slopes, unmitigated



Cereals, minimum tillage



Site 9 – Tunisia, Zuess Koutine

Introduction

The Zeuss Koutine area in Tunisia suffers from over exploitation of the aquifers, and extension of orchard cultivation at the expense of natural grazing lands. Severe long drought periods reduce soil water content to levels where olive plantation can suffer enormously. Traditional water harvesting techniques (Jessour and Tabias) are used for the improvement of water content of soil. Replenishment of groundwater aquifers are ensured through the recharge structures (gabion check dams and recharge wells). However, current cropping levels versus water availability may not be sustainable. The experiments are geared towards monitoring water levels, as the water harvesting techniques are well established. Moreover, ever since the ground water has been exploited by means of drilling a lot of pastoral land was converted into irrigated cropland or orchard. This has increased the pressure on the remaining land causing over grazing and associated soil erosion problem. An experiment was carried out to improve plant cover and biodiversity in the grazing areas aiming at minimizing land degradation.

Desertification indices

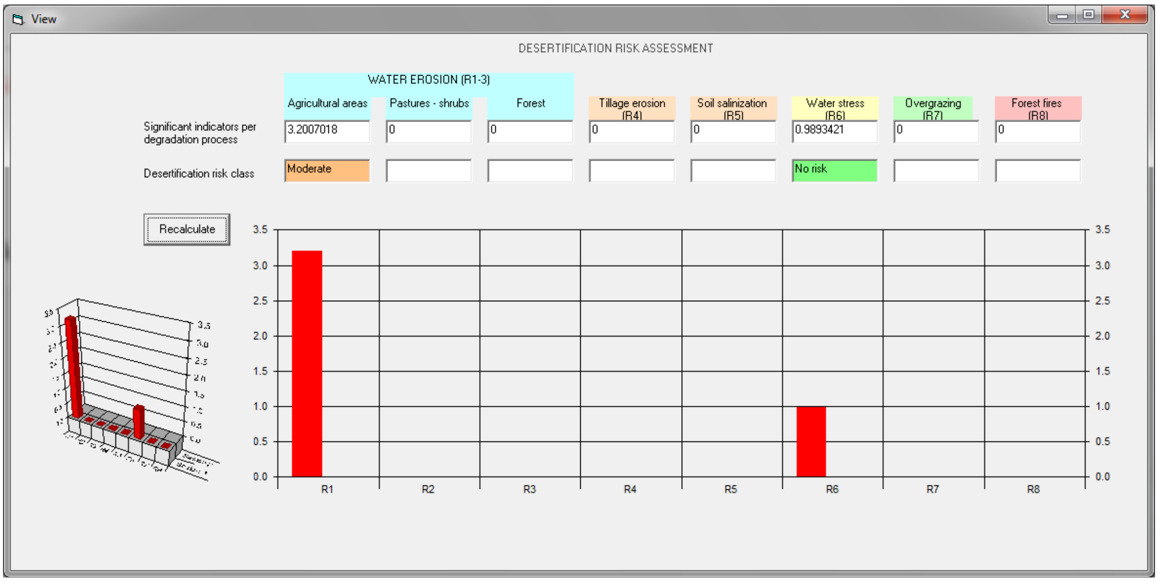
The two desertification risk indices investigated here are **soil erosion**, **water stress** and **overgrazing**. Soil erosion is not a problem on the fields where the technologies are tested but occurs elsewhere in the area.
In the first area the calculations do not make much sense. The soil erosion risk is calculated as moderate (3.2) while the precipitation is very low (although the seasonality is high), there is terracing so the slope angle is < 2%, the soils are well drained soils and there is efficient runoff capture.
On the other hand the water stress risk is indicated as no risk (0.99), but for this index the rainfall amount is not included, only the seasonality! The amount of rain does not seem to play a role with water stress in the system.
Water harvesting techniques are not included, unless this decreases groundwater use in which case the water stress risk remains at a “no risk” level.

In the south of the area heavy grazing takes place and the overgrazing risk is classified as low (2.11). When rangeland restingis implemented the set aside area has a large increase in cover and biomass. This decreases the overgrazing risk to 1.78 (still “low risk”).

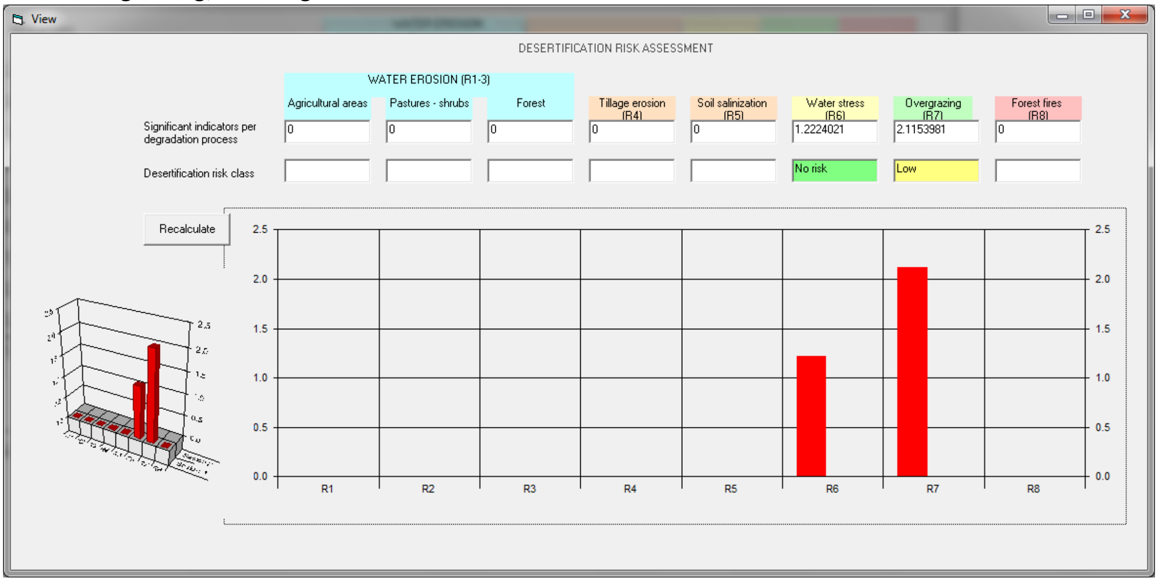
Conclusions

The system is not well equipped to deal with water stress in this very dry area. The factors leading to water stress are statistically chosen which creates some strange omissions (e.g. rainfall amount is not a factor in water stress). The grassland improvement is better simulated with an increase in cover as a result of rangeland resting.

Olive trees in a Tabias water harvesting system



Extensive grazing, unmitigated



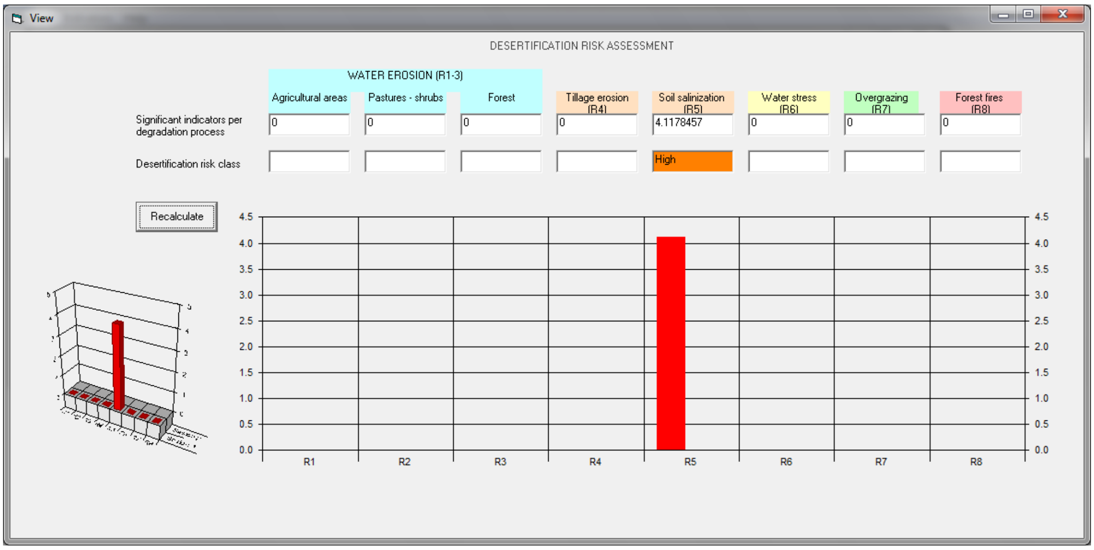
Site 10 – Russia, Dzhanybek

Introduction

The “Dzhanybek” study area is situated on the territory of Pallasovsky District, Volgograd Region, which is a dry steppe area situated at the left bank of lower part of Volga River valley. The climate of has a number of negative characteristics (drought, dry hot winds, dust whirls etc.) but also positive factors as warm summers and high radiation allows the valuable agricultural cultivation. The irrigation of crops in this region (situated at about 100 km from Volga River and very scarce local resources of fresh water) was stopped in early 2000 due to increasing of costs for water delivering strongly linked to high price for energy. Working equipment was sold, the old units finally broke down. Water storage capacities at the territory were absolutely dry for already 4 years from beginning of project activities. Before, they were used to be filled with snowmelt water. Unprofessional vegetable farming for domestic use is also under threat. High evaporation and shallow groundwater lead to salinization of the soil. Nowadays the main income of the stakeholders is agricultural production from their garden plots (fruits and vegetables), growing cattle (sheep and cows). There is a big agricultural conglomeration – farm “Romashkovsky”. The young generation is leaving rural areas due to level of life and possibilities to find more income in the urban area. Lack of information about sustainable land management, climate instabilities and weak institutional support with low financial support from the government makes the life of people in this region difficult. The experiment focusses on testing drip irrigation as a water conservation practice while generating a viable crop yield.

Desertification indices

The main desertification process is **salinization**. The risk is calculated as very high (4.56) because the annual precipitation is low (400 mm) the evaporation is much higher and irrigation water is from partly saline groundwater. When drip irrigation is simulated with partly fresh water and assumed this causes a reduction of overexploitation of groundwater to local pockets, the salinization risk drops to moderate (3.41). This depends also on the drainage of the soil, in places which are well drained the risk is moderate (3.29) and very poorly drained soils still have a high risk (3.70).



Conclusions

The system deals relatively well with the actual situation and the proposed technology (drip irrigation with fresh water), because this can be translated in variables that occur in the system.

Site 11 – Russia, Novy

Introduction

The Novy study site covering the Marksovsky Region of Saratov Oblast is situated at left bank of Volga River, and has a semi-arid climate. A long warm and dry summer with little rainfall every second year makes an extensive rainfall based agriculture practically impossible. Considerable land use changes have taken place over the last 40 years while first large irrigation system been constructed based on sprinkler irrigation use. This has caused regional ground water rising and secondary salinization appearing, as well as of developing of zones suffering of local runoff and water erosion by excessive irrigation. The collapse of the Soviet Union and increased socio-economic crises with rising prices of energy (pumping water from the Volga river), the use of irrigated land at Marksovsky Region diminished more than 5 times from its original size. Sprinkler irrigation was partly replaced by furrow irrigation, which is less expensive (no pumping) but has a low efficiency. as much water is lost because of low infiltration rates. This in fact generates soil erosion in the furrows and sedimentation of agrochemicals in nearby ponds. Drip irrigation has a much better controlled application of water below the surface, which conserves water and prevents erosion.

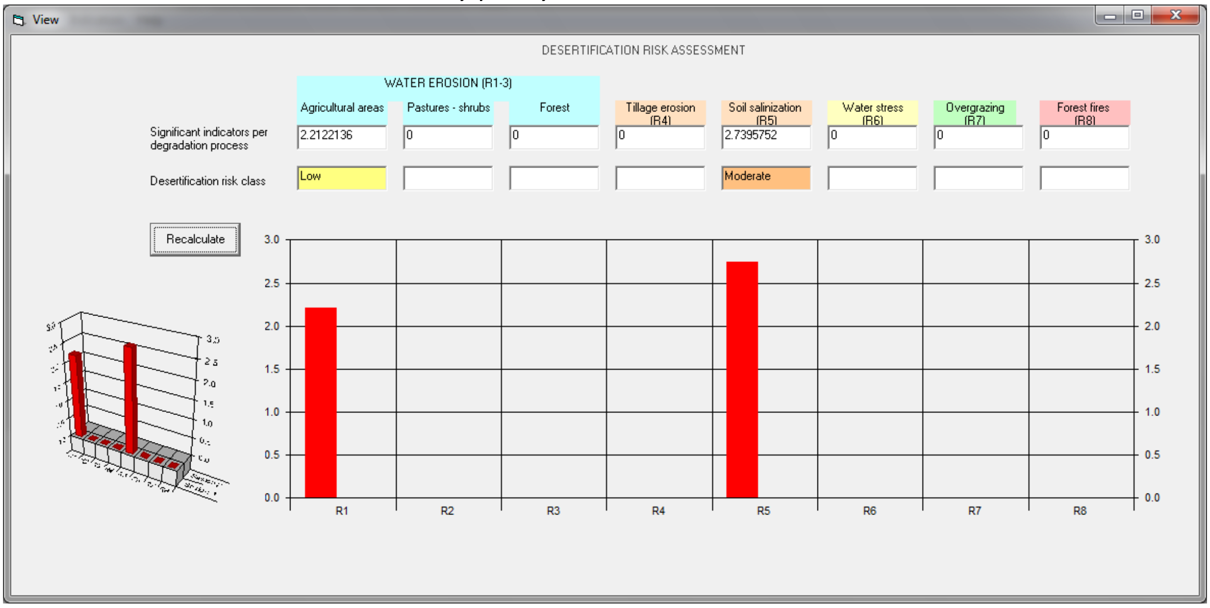
Desertification indices

The main desertification process is **salinization** and **water erosion** because of excessive irrigation. The salinization risk is calculated as low (2.39) which correctly reflects the situation as the irrigation water source is fresh river water. On very poorly drained soil this risk may become moderate (2.68). The erosion risk is calculated as low (2.21) which is logical because excessive irrigation is not a factor in the system and the natural rainfall would not cause erosion.

Conclusion

The system correctly identifies the salinization risk but cannot calculate the man-made erosion risk which is logical.

Erosion and Salinization risk and onvery poorly drained soils



Site 12 – China, Kelaigou village

Introduction

On the Loess plateau area in the Yan river basin in China, severe soil erosion is common. This results in deep gully and badland formation on the steeper slopes. To rehabilitate gullies, check dams have been constructed. These limit runoff and sediment delivery downstream and increase water availability for maize. The slopes can be stabilized with terrace constructions. Because of annual rainfall fluctuates between 400 and 1100 mm (average 560 mm), water can be a limiting factor in this region. Soil water conditions are monitored and compared to crops on the slopes, as well as runoff and erosion under different land uses. The erosion is especially important downstream while the conservation measures are tought to be important on site (because of soil moisture increase).

Desertification indices

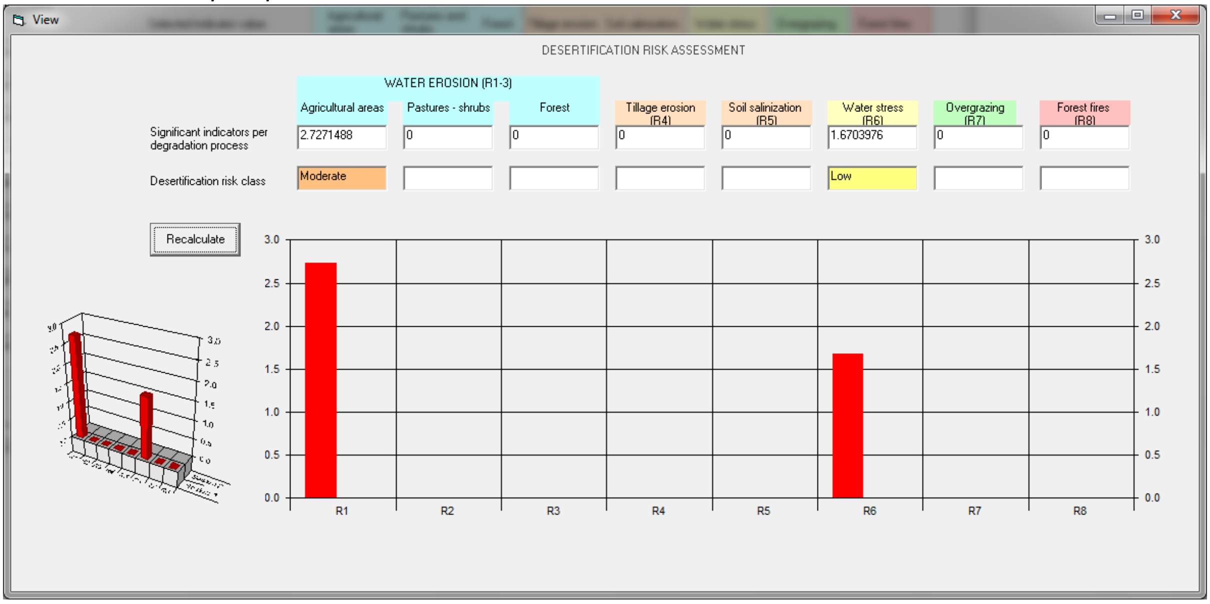
The main desertification process is **water erosion** and secondary is **water stress**, because of erosive soils (loess) and occasional heavy rainfall. Erosion risk is classified as moderate(2.72) in spite of the very steep slope and bare soil and absence of conservation measures. Water stress is classified as low (1.67) probably because of the absence of a direct link between amount of rainfall and water stress in the system.

Applying a terraced situation results in a slight lowering of the water erosion risk which is starnge because apart from choosing terraces as conservation the slope is set to < 2%. The water stress is correctly lowered to “no risk” (1.32).

Conclusion

The water erosion react counter intuitively to a lowering of the slope from >35% to < 2% with hardly and change, while the water stress is correctly reduced considerably.

Bare area on steep slopes with loess soils



Site 13 – Botswana, Boteti area

Introduction

The Boteti study area has overgrazing as the degradation challenge. The extent of overgrazing in pastures, woodland and settlements is fragile to critical. Firewood collection adds to the range degradation, thus alternative energy in the form of biogas has been proposed by the stakeholders. Firewood is the main source of energy, not only in common households but also in schools and communal centers. Since cattle is one of the main sources of income, biogass might be a valuable alternative. The generated gas is expected to reduce heavy firewood use and even promote socio-economic activities which will reduce poverty – perceived to be one of the main drivers of land degradation other than droughts.

Desertification indices

The desertification risk analyzed here is **overgrazing**. Using the parameters for a flat poorly vegetated area with deep soil, the overgrazing risk is considered very high (4.76). The two main factors here are however to do with farm size. Since there are no farms but communal grazing areas the selected variables are larger than 100 ha and low fragmentation 1-4. If these variables are not included the overgrazing drops respectively to low (2.41). Biogas cannot be done directly. The only thing that can be assumed is that the cover increases, but this has little influence.

Conclusion

The communal razing cannot be correctly identified in Botswana, overgrazing is classified as high risk but for the wrong apparent reasons (farm size), which overrule other changes in the system (vegetation related).

Site 14 – Mexico, Cointzio

Introduction

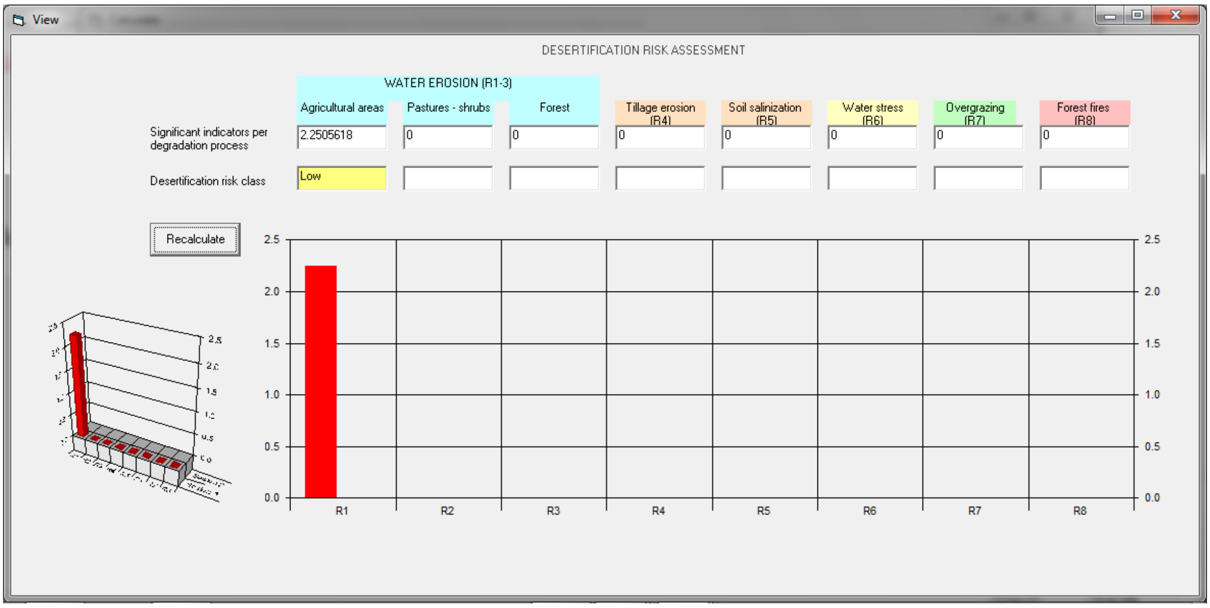
In the Cointzio basin, land degradation is mainly due to free grazing of cows. To avoid this, a global solution must be searched and must be adapted to different environmental situations. Due to the critical economic situation of farmers, men and women can act only with subsidies (local projects), managed by political authorities. The Cointzio basin has different kinds of soil erosion due to the type of climate (temperate semi-humid with a 6 months rainy season), soils and geomorphology as well as land uses (some mechanized farming, mainly rainfed agriculture with free grazing cattle, forest, recent avocado plantations). Apart from the land degradation, the downstream effect is the refilling of the Cointzio dam used for drinking water of the capital of Michoacán, as well as occasional severe flooding. One of the techniques tested is the effect of crop rotation, including minimum tillage, on sediment losses.

Desertification indices

The desertification risk calculated is **water erosion**. The calculated risk is moderate (2.58). Introducing a rotation system will presumably increase the soil cover which is an option in the system. This lowers the risk to low (2.37) while the minimum tillage further reduces the risk to (2.25).

Conclusions

The system correctly identifies the risk for water erosion in this area and the effect of the mitigation measures.



Site 17 – Chile, Secano Interior

Introduction

In the dry Secano interior in Chile, farmers face problems of soil fertility depletion which affects the sustainability of traditional crop production. Another problem associated with fertility depletion is erosion because of periods in the crop rotation cycle where the soil is bare. Experiments were carried out to introduce crop rotation with legumes to replace wheat mono culture and to solve the problem of soil fertility depletion, while at the same time providing a better soil cover and also improving the soil structure, which improves infiltration.

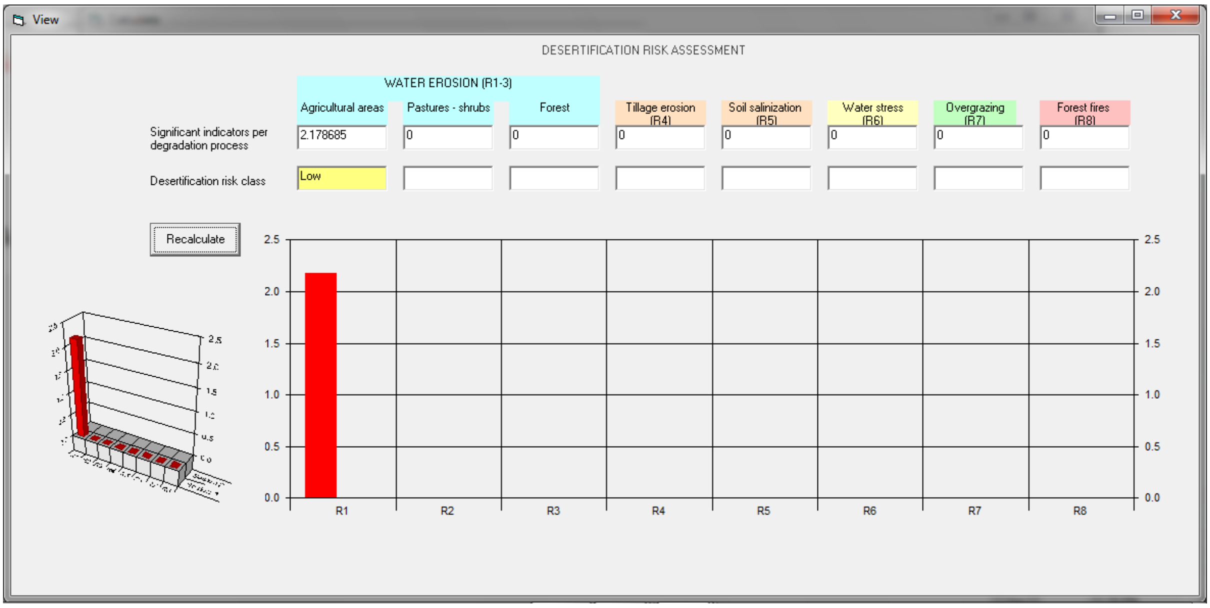
Also the problems of soil erosion and soil degradation are caused by the Mediterranean type of climate (heavy rainfall in winter) and inappropriate land management practices. Experiments were carried out on the experimental farm to decrease surface runoff and soil losses and to improve soil water availability for growing crops.

Desertification indices

The desertification risk calculated is **water erosion**. The calculated risk is moderate (2.52). Introducing a rotation system will presumably increase the soil cover which is an option in the system. This lowers the risk to low (2.30) while the minimum tillage also results in an even lower risk (2.18) because the ploughing is stopped.

Conclusions

The system correctly identifies the risk for water erosion in this area and the effect of the mitigation measures.



Site 18 – Cape Verde, Ribera Seca

Introduction

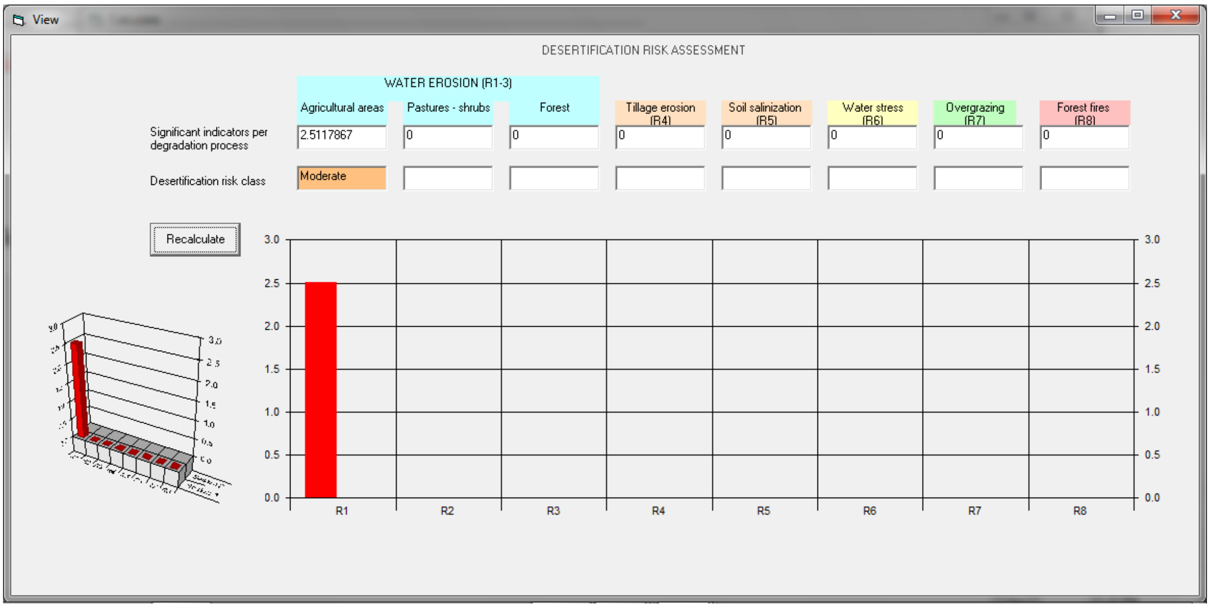
Cape Verde has been facing to severe environmental problems impact for the people living in the island. In order to control desertification (drought, storm runoff, erosion) the government has been taking actions regarding biodiversity conservation, ecosystem management and better valorisation of water resources. Slanting terraces as a form of conservation are widespread, but in the dry climate vegetation cover is low and the terraces do not always have the desired effect. The experiment aims at improving the system with vegetation barriers.

Desertification indices

The desertification risk calculated is **water erosion**. The calculated risk is moderate (3.23). Introducing slanting terraces and runoff barriers lowers the risk to moderate (2.94) if the angle of the terraces is low (< 2%). When the edge of the terraces are planted this is translated to an increase in cover and runoff control measures the risk is further decreased to moderate (2.51).

Conclusions

The system correctly identifies the risk for water erosion in this area but the effect of the terraces is not very clear, a lowering of the slope angle seems to have very little effect.



Conclusions and recommendations

1) Overall the results are good, the tool shows what it is supposed to show: a lowering of a risk coincides with the application of a technology, in almost all cases. Since the risk factor is based on multivariate statistics, both the calculated risk, and the change of risk after application of a technology is relatively smaller than the experimental results often indicate. This is logical because the tool is an average of all sites and the effect of a particular situation will then be less pronounced.

2) The results indicate that overall the system that there are advantages and disadvantages. The advantages are that first you get a single value for a desertification risk with which you can compare all sites, so very different processes become comparable, and second, if so desired, you get information on desertification risks that were not initially researched at a site. For instance an experiment that is meant to control water erosion also may have a certain risk for tillage erosion or water stress although this was not the subject of the experiment. Thus you get more information and a wider context.

3) In the future, the system could focus more on conservation and mitigation measures, this would make valuable addition, and permit much more than calculating a risk. This is logical: the system was based on many observation points in each site, but since most of these sites have no widescale implementation of conservation measures, conservation is not part of the multivariate analysis. Conservation measures that are included are: conservation tillage types, a decrease of slope (terracing) and an increase in soil cover/mulch. At this point many technologies have to broken down in the processes they aim to affect but there is some interpretation needed for this. Contour ploughing could be interpreted as runoff control, intercropping as an increase of cover, drip irrigation as a decrease of overexploitation of groundwater, terraces must be combined with a decrease in sloep and runoff control before it has effect. At this point there is some freedom to make the system do what you want and like all models background knowledge is needed to operate it correctly.

4) Some variables are really regional variables that do not change as a result of a technology (degree of land abandonment, climate, deforestation degree etc), and are therefore not distinctive between a traditional way of farming and an experiment. If these have a large effect in the end result they 'overshadow' the variables that are related directly to an experiment.

5) Some relations are counter intuitive and show that this is a statistical tool and not a process based tool (although the variables link to processes). The most important are: rainfall amount is not a factor influencing water stress risk, only seasonality is. You can generate water stress in an areas with > 1500 mm rainfall, or no water stress in an area with < 280 mm of rainfall.Neither slope nor soil cover seems to affect water erosion very much, when many other factors are involved. Implementing terraces with a slope of <2% has little effect, as does implementing a full surface cover. Also processes are not linked: for example the effect of terraces in China is an increased water availability because of the increased infiltration on the flat surface as opposed to the sloping surface, but this relation is not included in the statistical basis of the indicator system and will therefore not show up. So terraces do not alleviate water stress.

The system generally does what it is supposed to do and the risk factors reflect the experiments as reported in deliverable 4.3.1 well. Some experience and knowledge is needed to operate the system correctly. A clear advice for a future extension of the indicator system is to i) extend the dataset with a focus on conservation measures, and ii) show the relative importance of the many variables so that it is clearer which variable has the largest influence on the result. This helps in understanding how the desertification index is generated and how large the effect of a technology must be to generate a difference, a decrease in risk, iii) look at counterintuitive relations that are apparent and somewhat confusing.