IT CONTROLLED IRRIGATION

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SOME FACTS ABOUT IRRIGATION


Farming: Wasteful water use
Excessive water use for agriculture is leaving rivers, lakes and underground water sources dry in many irrigated areas.

Agriculture: the greatest user of water
Globally, the agricultural sector consumes about 70% of the planet's accessible freshwater – more than twice that of industry (23%), and dwarfing municipal use (8%).
SOME FACTS ABOUT IRRIGATION


Wasteful and unsustainable

Many big food producing countries like the US, China, India, Pakistan, Australia and Spain have reached, or are close to reaching, their renewable water resource limits.

The main causes of wasteful and unsustainable water use are:

• leaky irrigation systems
• wasteful field application methods
• cultivation of thirsty crops not suited to the environment.

The problem is made worse by misdirected subsidies, low public and political awareness of the crisis, and weak environmental legislation.
SOME FACTS ABOUT IRRIGATION


Multiple environmental impacts

• Unsustainable water use harms the environment by changing the water table and/or depleting ground water supplies.

• Excessive irrigation can also increase soil salinity and wash pollutants and sediment into rivers – causing damage to freshwater ecosystems and species as well as those further downstream, including coral reefs and coastal fish breeding grounds.
IS THIS REAL? - WATER USE BY SECTORS
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Water use by sector

An unsettling number of large rivers—including the:

- Colorado River,
- Rio Grande,
- Yellow River,
- Indus,
- Ganges,
- Amu Darya,
- Murray, and
- Nile

are now so overtopped that they discharge little or no water to the sea for months at a time.
IS THIS REAL – RIVERS DON’T REACH THE OCEANS

Colorado River Delta
IS THIS REAL – ARAL SEE SHRINKING
WHY IS IRRIGATION WASTING WATER

• Distribution Losses
  Huge loses in distribution network (earth channels, open channels, network leaking, wrong distribution...)

• Irrigation Techniques
  Efficiency: Furrow irrigation 50%, Sprinkler Irrigation 70%, Drip Irrigation 90%

• Irrigation Scheduling
  Full irrigation is to add water always when soil moisture level deplete below critical point. Deficite irrigation can reduce water supply in less sensitive stages without yield reduction. Farmers have no means for proper irrigation scheduling

• Farmers knowledge
  Naturally farmers tend to overirrigate their fields due to low knowledge on processes
IT IN IRRIGATION

IT technologies can contribute in various ways to improve water use efficiency, to reduce water losses and to produce same food amount with less water

• On System Scale (better distribution of the water in the network – optimization, automation etc.)
• On Farm scale (improved irrigation scheduling, improving know-how transfer)

What we are doing
• Our team work with on-farm irrigation
• Promoting of drip irrigation and fertigation
• Promoting proper irrigation scheduling
• Increasing farmers knowledge and know-how
CASE STUDY PELAGONIA
Project: Interactive Farmers Support System for Efficient Water Use Management-RULAND


The overall objective of the project was to develop a cross border interactive farmers’ support system that will help farmers to improve their water use efficiency, as well as to improve their yields and economical benefits.

The efficient water use management will provide significant environmental benefits as decreased pressure on water resources in the region as result of the decreased water use in the agricultural sector.
IT was a simple task. 
But we had to develop:
Soil map (very detailed), so we collected all available historical soil samples and conducted tents of new analyses. The geo-database was developed. The important soil properties collected were: Field capacity, Wilting point, water retention.

We had to develop historical weather database for the region, but irrigation practice need real time weather information. So we installed 3 automated weather stations in order to collect real time weather

We decide to develop system for maize and we collected all crop phenology available and created the database
CASE STUDY PELAGONIA

SOIL MAP
Is soil map enough to create system for advising farmers on irrigation?

No, soil map contain just basic properties and soil names. We need data on soil water properties, So we used number of soil profiles to interpolate these properties. Then we validate our interpolated data.
CASE STUDY PELAGONIA

When we created databases on soil properties and crop properties we developed 3 different scenarios on model used to calculate crop water requirement and irrigation water requirement namely based on evapotranspiration, based on soil water balance and water sensors and combination of these two, evapotranspiration and soil water balance with sensors.

The final decision after validation was combined scenario, and with 3 control points for soil moisture, everything calculated in real time…

Finally we overlapped all our databases with cadastral maps in order to associate each parcel with its soil water properties, crop water requirement, irrigation water requirement and crop development and phenology

The idea was each farmer to register with the cadastral number and to get data tailored for his own field. Moreover if he add more data, more accurate information will get.
Then we made choice of the equipment:
The Automated Weather Station was based on Campbell Scientific data logger and Vaisala sensors

Soil moisture measurement was based on Irrometer granular matrix sensor Watermark SS 200
The real time data acquisition was designed using GPRS system provided by Campbell scientific and smart routers.

THE FINAL STEP – SOFTWARE

The IT company was subcontracted for coding

The problem was that they were not able to make all components to operate simultaneously. There was data gaps, and always by fault of somebody else…

So the system was not very popular and never reached sustainable number of user. Due to lack of resources for maintenance system is not operating in present
WE STARTED THIS PROJECT WITH SOME LESSON LEARNED:

• The most important part is sustainability. Project should be sustainable.
• Farmers are interested only in their own field, nothing else.
• Farmers need complete service, solving the problem only for irrigation will leave farmers without information on crop diseases and pests, spraying, fertilization etc.
• Moreover irrigation is not most costly activity and it is finally not the most sensitive one. The errors in irrigation will not heavily damage the crop as some other errors.
• So this time we decide integrated system, with clear user and increasing the level of importance of each farmer
The support for this project come through a project for Implementing environmental measures in Prespa lake region, financed by Swiss International Cooperation and Implemented by UNDP.

So we had different objectives: to reduce pollution of Prespa Lake catchment using modern agricultural measures.
CASE STUDY PRESPA LAKE

FIRST STEP

Serious analyze of the situation in the region: irrigation, crop protection, fertilisation practices, pomological measures etc.
CASE STUDY PRESPA LAKE
CASE STUDY PRESPA LAKE

Agriculture has a significant role in Resen municipality in terms of employment and economic sustainability. Currently over 60% of the total population of Resen municipality depends on agriculture, mainly apple production.

There is total of 3850 ha of apple cultivating land in the Prespa region and about 2700 farmers.

The agricultural development within the Prespa Lake basin makes serious pressure to the water quality and quantity mainly due to the uncontrolled use of agrochemicals (fertilizers and pesticides) and the unsustainable irrigation practices.
The Prespa Lake watershed management plan recommends measures to be adopted for agricultural production:
• to minimize the use of irrigation water,
• minimize pollution by agrochemicals and
• to establish environmentally, economically and socially sustainable agricultural and irrigation management and practices.

Therefore the activities undertaken in the projects were aimed to development and spreading of advanced practices for irrigation, fertilization and crop protection.

The emphasis was on promoting environmentally friendly agricultural practices that have positive impact on crop yield and/or reducing production cost.
CASE STUDY PRESPA LAKE

Before the start of the project we conducted a survey with farmers, local extension service and Local unit of ministry of agriculture in order to assess common practice in the region. The situation was:

IRRIGATION:
Farmers use drip irrigation but overirrigate. They use 2 drippers of 6-8 l/h per tree. Duration of irrigation is 4 – 7 days (96-168 hours). During that period minimum of water application per hectare is 1152 – 2688 m3/ha, that is enormously high for predominantly sandy soils in the region and a lot of water is deep percolated and cause pollution. Number of applications is 4-8. According to this maximum amount for irrigation per year is 21404 m3/ha, is 8649 m3/ha that is more than double of irrigation water requirement for apples in Resen calculated by FAO 56 method (4530 m3/ha).
# CASE STUDY PRESPA LAKE

## FERTILIZATION:

<table>
<thead>
<tr>
<th>Fertilization and Period</th>
<th>Fertiliser Type</th>
<th>Quantity (kg/ha)</th>
<th>Active substances (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Basic autumn fertilization</td>
<td>NPK 4:07:28</td>
<td>700</td>
<td>28</td>
</tr>
<tr>
<td>Early spring fertilisation</td>
<td>NPK 15:15:15</td>
<td>500</td>
<td>75</td>
</tr>
<tr>
<td>Late spring fertilisation</td>
<td>NH$_4$NO$_3$ 34%</td>
<td>400</td>
<td>136</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1600</td>
<td>239</td>
</tr>
</tbody>
</table>

**Total for 3850ha in tones:**

6160 920 477 1043
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FERTILIZATION:

The machine spreading over the soil surface is in practice

After fertilization soil is cultivated to incorporate fertilizers into the soil

No depositors are in use

Farmers follow the same pattern without respect of soil analyses

The accumulation of phosphorous and potassium in some cases are very high
CASE STUDY PRESPA LAKE

FERTIGATION AND IRRIGATION SCHEDULING:

Almost not in use, but equipment required was not available on the market

GREEN COVER IN ORCHARDS:

Implemented by few farmers that were using fertigation and already purchased equipment for grass moving and soil cultivation in the tree row (narrow strip of soil in the row is cultivated)
CASE STUDY PRESPA LAKE

CROP PROTECTION

Farmers are ready to follow recommendations from the system for crop protection (crop diseases and pest prediction)

They prefer SMS to other forms of information (local radio station, Facebook)

The average number of pesticide application was 10-17 applications with one or more pesticides
## CROP PROTECTION – PESTICIDE USE

<table>
<thead>
<tr>
<th>Pesticide type</th>
<th>Quantity (tons)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungicides</td>
<td>38.5</td>
<td>60%</td>
</tr>
<tr>
<td>Herbicides</td>
<td>3.2</td>
<td>5%</td>
</tr>
<tr>
<td>Insecticides</td>
<td>22.5</td>
<td>35%</td>
</tr>
<tr>
<td>Total</td>
<td>64.2</td>
<td>100%</td>
</tr>
</tbody>
</table>
UNDP (Skopje office) for more than 15 years supported the activities in promoting environmentally friendly agricultural practices in Prespa Region, so we were present in the region for long period and already did some activities (more or less successfully).

- Improving irrigation practice (replaced furrows with drip irrigation)
- Promoted of irrigation scheduling (introducing of tensiometers)
- Promoting fertigation
- Establishing the soil laboratory for recommending fertilization
- Promoting fertilization based on soil analyses
- Establishing of network of mini meteorological stations and system for predicting and announcing the risk of crop diseases and pests
- Promoting green cover in orchards
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We entered in the project with very good understanding of the situation in the region and most common farmers behavior.

About 70 farmers got grants in equipment

All previous trainings were sublimated, reduced and emphasized to the several goals in the whole training process.

The experimental orchard with very modern technologies was established in order to show technologies in the field

This approach was probably better than our previous attempts (or whole idea was mature enough)
CASE STUDY PRESPA LAKE

What we did:

For irrigation: Each farmer got set of tensiometers, data logger (Cambell Scientifics, Watermark SS200 sensors). They were trained to use this equipment to download data, create graphs and understand soil water dynamic.

For fertilization: We established laboratory for soil and crop analyze and recommendation of the fertilization practice. Also we introduced fertigation as measure to add nutrients as required by time and amount.
CASE STUDY PRESPA LAKE

What we did:

For crop diseases: We established system of 7 AWS (Pessel Instruments) with ready made software for 2 most common diseases (Apple scab and Powdery Mildew). The AWS are equipped with module for Evapotranspiration and we used for deriving crop and irrigation water requirement.
CASE STUDY PRESPA LAKE

What we did:

For pests: pheromonic traps for estimating the population and economical threshold for spraying. One site is equipped with camera for automated counting of the insects number and estimating of economical threshold for pesticide application.
CASE STUDY PRESPA LAKE - RESULTS

IRRIGATION: We reduced water use for 60%

IRRIGATION SCHEDULING: In practice only in fields that got equipment as an grant, but there is positive signs for spreading the use. We should redesign our approach similar to crop protection system

FERTIGATION: About 10% of the farmers start using it

FERTILIZATION: Farmers start using soil analyses and reduced fertilizer use for 30%
GREEN COVER: About 40% of farmers started using it due to increased availability of required machinery in the region with tendency of rapid increasing, that will almost eliminate transport of phosphates with run-off water.

CROP PROTECTION: Reducing of the number of sprayings by half (7-10), accordingly and pesticide use for 30%. More than 90% of the farmers follow recommendation delivered from the system.

Pheromone traps are promoted and used for predicting spraying against pests (insects)
CASE STUDY PRESPA LAKE

MOREOVER!!!!

The waste apple and spring yard waste are composted with chicken manure from the big chicken farm.

The pesticide packaging is treated accordingly as dangerous waste.

The water is regularly monitored. Results show rapid decrease of nutrients and pesticides into the lake water.

The modeling of eutrophication was conducted by US company “Stone Environment Inc.” and their models using the pre and post project results are very similar.
CASE STUDY PRESPA LAKE

IS THIS SUCCESSFUL STORY??
I believe YES

UNDP supported picturing of the documentary entitled as “Lake of Apples” based on the achievements presented in this case study

So, probably water quality is not related with water management institutions and bodies. The water quality is subject that should be carefully analyzed and solved on its start. Particularly problematic is working with diffuse source of pollution, as agriculture is.
CASE STUDY PRESPA LAKE

IS THIS SUSTAINABLE??
I believe YES

Practices promoted are increasing yield, reducing cost of the production, reducing labor.... Farmers like it.

We never mentioned lake and water, we spoke about new technologies, new practices, better yield, higher income, better market access...

The participating farmers now promote technologies, transfer know-how and overtake our role.

Will we go back in Prespa? Readily, after several years with new ideas, new and better technologies... That will keep the lake in a life...
PRESENT ACTIVITIES

DOES PRESPA LAKE EXPERIENCE CAN BE TRANSFERRED AND UPSCALED EASILY??
I believe NO!!!!

Same team work in Strumica river basin with 60 farmers, but more crops, bigger total number of farmers etc. Farmers do not easily accept our recommendations. They took the equipment, they use what they believe is OK for them and most of the equipment is not used.

Probably we miss first 10 years of promoting ideas step by step. We started with big game (grants) in very early stage and I believe we will fail, but we have 2 years more, maybe something will change…..
PRESENT ACTIVITIES

The choice of equipment for the projects is good, but very expensive for small farmers. We are now working on development of low cost equipment that will do the job and will be affordable for small farmers. Moreover we hope that each farmer can equip his field with low cost AWS and soil water monitoring system.

We hope that these low cost systems will provide data for further development of our activities, particularly in the direction of big data collection on agricultural activities.

We work on several new low cost pieces of equipment:
PRESENT ACTIVITIES

AWS based on Arduino, Raspberry Pi, Orange Pi and digital sensors. The use will be in irrigation and crop protection. Our team of crop protection is calibrating models for diseases.
PRESENT ACTIVITIES

3 Low cost agricultural drones (surveillance, imaging – NDVI with converted Canon Camera, Spraying)
PRESENT ACTIVITIES

System for acquisition of soil moisture based on Zig-Bee technology (wireless) to avoid wires in the field, equipped with display for direct reading and graphical presentation of soil water dynamic.
PRESENT ACTIVITIES

We hope that low cost equipment that will be produced locally will increase use of the IT in agriculture among small farmers.

The big farmers are reach and will run for proven technologies of the companies we can not compete with.

We have very negative experience in cooperation with IT sector (programers) that watch on the IT in agriculture just as another customer. Asking for information's and do not even mention who provide data for the product. But, even though for IT experts Agricultural knowledge is just piece of cake, we spent decades on collecting day by day our data that are base for development of the IT systems in agriculture.
PRESENT ACTIVITIES

So our team decided do not cooperate with IT sector without clear contract of the benefits we will get for our lifetime collected knowledge on local conditions for agricultural production. We know what farmers need, what farmers like, what crop need, how to determine crop requirements, how to supply required elements...

Due to this we started with developing skills in using embedded computers and basic programming.

In the moment we are directed toward open hardware and open software platforms, but....

Maybe this decision made us to move much slower than we should, but....
THANK YOU FOR YOUR ATTENTION!!!!

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