HYDROLOGICAL IMPACT OF REFORESTATION IN AYUBIA NATIONAL PARK

Project Proposal
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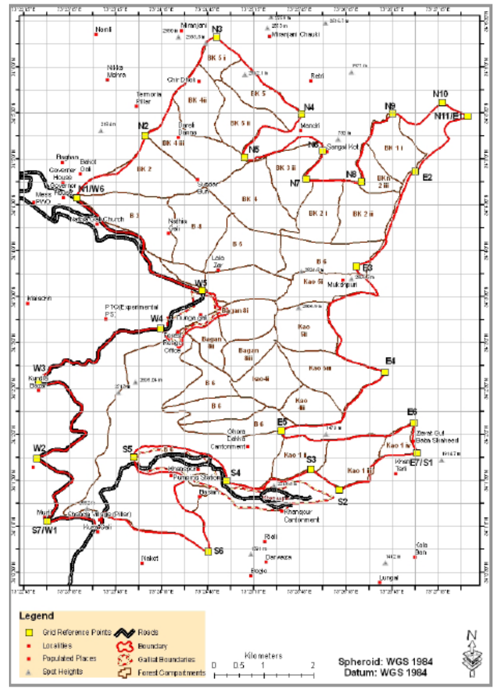


PURPOSE:
Water springs in Ayubia National Park are drying up and it is believed that forest clearing is responsible for this. Especially the unprotected forests on the borders of the park have been extensively cleared (for firewood) and are used for grazing. More dry springs have been recorded in these areas. The Coca Cola Company wishes to become water neutral and therefore wants to know the quantitative hydrological effects of its reforestation campaign in Ayubia National Park. We will model soil water content as a function of tree density, taking into consideration soil type, precipitation, temperature, tree specie, slope and the effects of grazing. We hope our study will help in increasing the water flow in the springs.

BACKGROUND
Ayubia national Park is spread over 3,312 ha of Western mixed coniferous forests. Although protected as a national park, its resources still come under great pressure due to the presence of 12 villages on its borders. Human activities in the forest have resulted in changes in key forest properties. This change must be carefully followed and documented so that the forest may be properly conserved. Ayubia National Park has international significance as it forms part of the Western Himalayan global eco-region.

SCOPE
All 4 students will engage in data collection over a one week period, from 14th July to 20th July. Some sites that Mr. Syed Kamran used will be revisited while a statistically significant number of other sites will be chosen with regard to the extra parameters. Soil samples will be tested and data organized after returning at LUMS and other labs in Lahore or Faisalabad.

THEORETICAL FRAMEWORK
The study of soil hydrology is a complex one with a wide number of interlinked variables. We extensively studied international research papers on the subject and have come up with simple models that are feasible and are easily performable with the available equipment.

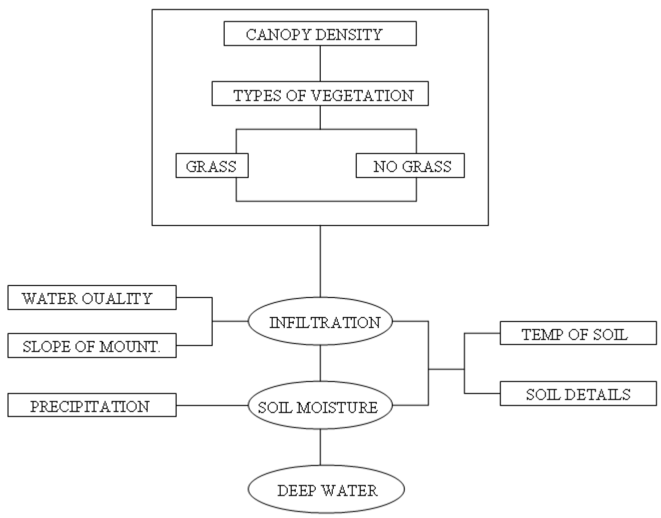
PLAN A

TO MATHEMATICALLY MODEL THE RELATIONSHIP BETWEEN VARIABLES OF THE HYDROLOGICAL ECOSYSTEM OF THE FOREST

We shall make mathematical equations that relate the following parameters by regression models. The parameters under consideration are:

Forest density	Water infiltration rate	Slope of the mountain
Precipitation	Vegetation type	Temperature of the soil
Grass cover	Extent of grazing	Temperature of air
Humidity	Water quality	Soil properties
Water content in the soil.		

The following diagram describes certain relation that we will try to map:



A regression analysis is used for modeling and analyzing several variables mentioned above. The focus is on the relationship between a dependant variable and one or more independent variables. Regression analysis estimates the conditional expectation of the dependant variable given the independent variables. The estimate target is a function of the independent variables called the regression function.

PLAN B

If due to lack of equipment or insufficient data points we are unable to find definitive equations, we will model the following relations.

A. How forest density affects the infiltration rate
B. How forest density affects the soil moisture content
C. How grazing (herbaceous cover density) affects the infiltration rate
D. How soil texture affects infiltration rate
E. How areas of different forest specie affect the infiltration rate.
F. How the quality of water affects the infiltration rate
G. Others

The relations will be based on general linear regression models. If the regression model fails for any relation we will provide a simplified qualitative analysis. For consistent analysis we will ensure that variable parameters such as slope, temperature, soil depth etc are compensated for.

STATISTICAL TECHNIQUES

We will use the t-test to determine if the null hypothesis is correct and the goodness of fit as a statistical model to determine how well our hypothesis fits our set of observations.

FACTORS DETERMINING SITE SELECTION FOR EXPERIMENTS

We have obtained detailed maps from the WWF GIS labs. In determining our site we will take into account:

- Forest density depending on satellite images
- Distance from the existing tracks
- Areas near settlements for sampling grazing effects
- Areas of different forest species using the forest compartmentalized maps
- Distance from base camp
- Avoiding leopard conflict zones

METHODOLOGY

1. WATER INFILTRATION
    a. A double-ring infiltrometer consists of two concentric metal rings. The rings are driven into the ground and filled with water. The outer ring helps to prevent divergent flow. The drop-in water level or volume in the inner ring is used to calculate an infiltration rate. The infiltration rate is the amount of water per surface area and time unit which penetrates the soils.
    b. At least 4 readings at each site will be taken. It takes about 90-120 minutes to take one reading so we will simultaneously carry out experiments. Our target is to collect samples from 30 different sites.
    c. Ideally they will be taken close to one another and some under the canopy and the others outside. It has been shown that there is a significant difference in infiltration under and outside the canopy. (Joffre & Rambal, 1993)
    d. One infiltrometer will be provided by the WWF and we hope to construct and take three others with us.
    e. For taking the infiltrometer readings it is very important that the soil is already saturated. There are two ways to ensure this. The first is that you pour large

A double ring infiltrometer

amounts of water at the site until it becomes saturated and the second is you do the experiment as soon as possible after a precipitation event. In this way it will cost a lot less water and so we wont have to carry ridiculously large amounts of water. We have chosen this time of year as it rains over 1500 mm annually and the peak rainy season at the Ayubia National park is July-August.

2. SOIL SAMPLES

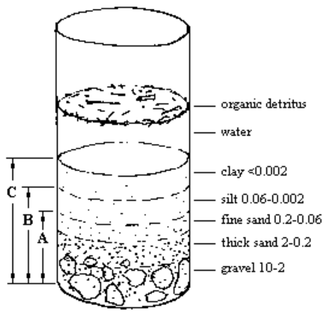


Figure 1 - Test for the composition of the soil.
(The sizes are in mm)

a. The infiltration depends on the composition and depth of the soil. Soil samples will be taken up to a depth of 30 cm. We will take a sample from the middle of the top layer (0-15 cm) and a sample from the middle of the lower layer (15- 30 cm). (Ranjith, 1995)
b. To produce our samples we will take eight to ten samples from each top and lower layer and mix them with their respective samples for consistency. From this mixture we will extract our desired samples.
c. We will store samples in plastic air tight test tubes and use parafilm to ensure the moisture is not lost. Test tubes will be stored in a plastic cooler to protect from sunlight and humidity and kept at moderate temperatures (Tan)
d. Samples will be brought back to the lab for analysis.
    i. Percentages of silt, sand, loam, clay and organic matter determined by sedimentation method. We will also use the feel method on the field to have a preliminary analysis. (Thein, 1979)
    ii. Soil moisture content will be measured by the change in weight method. The test tubes will be weighed before and after drying giving us the mass of water (tested in the LUMS chem lab)
    iii. Bulk density of soil (mass of oven dry soil/ sample volume). This will be measured by drying the soil in the LUMS chemistry lab
    iv. Currently Agriculture University Faisalabad and local laboratories are being consulted for determining the soil composition
e. Soil temperature will be measured at a depth of 10 cm at each site using a standard thermometer

Soil sampling technique

3. SLOPE

The slope is an important factor because the more the slope, the more gravity would pull water away from the sloped soil. We will use two 50 inch poles with a rope and a hanging notch to determine the slope.

4. PRECIPITATION, TEMPERATURE AND HUMIDITY LEVELS
    a. This data will be taken from the meteorological department

5. WATER QUALITY
    a. Water quality will be measured using a suitable device

6. TREE SPECIE AND FOREST DENSITY
    a. We will measure the forest density by counting the number of trees approximately in a area of $100m^2$, (10m x 10m) at each experiment site
    b. We will also tally this data with GIS maps
    c. The tree specie will be located with the help of the compartmentalized map and on-site observations will be made to determine the species.
7. OTHERS
    a. We will try to make as many readings as possible of additional parameters that do not effect directly but have some significance in our study. These include herbaceous cover, post humus organic material, average tree age and others.

Limitations: Seasonal variations in the park cannot be taken into account with this limited study. Ideally should be taken throughout the year. To completely map the ecological system we need extensive data of surface run off which includes the detailed discharge data of all springs in the area. To model a dynamic system we also require Evapotranspiration rates at different sites in the Park along with deep drainage data which requires expensive equipment such as neutron probes, tension meters and others. (Joffre & Rambal, 1993)

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