

PERMEABLE AREAS AND THE USE OF GROUNDWATER: A CASE STUDY IN CAMPUS I AT PASSO FUNDO UNIVERSITY, BRAZIL

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Abstract

The water from rainfall that may be retained in the soil or the surface can seep by gravity or capillary action and will form the underground phase of the hydrologic cycle. Permeability measures the greater or lesser ease each soil, when saturated, offers the piping of water through its interstices. The permeability depends mainly on the porosity, particle size and shape of grains. Rainwater crashing into the ground can promote compaction of the surface, reducing infiltration capacity, carry out and the fines which, by their subsequent sedimentation, tend to decrease the porosity of the surface, moisten the soil surface, saturating the layers close, increasing the penetration of water and act on particles of colloidal substances that engorge wet, reducing the size of the intergranular spaces, reducing infiltration and dry, shrink, forming fissures in the ground. The presence of vegetation reduces or eliminates this effect. Therefore, this study aims to analyze and assess the role of green vegetation in the drainage of water from the Campus I of Passo Fundo University and to minimize the main drainage-related impacts, and sustainability of groundwater use by the University for the various purposes. It is hoped by the results obtained contribute to a better local drainage because the water from the rains may have a delay of its runoff may facilitate the percolation through the soil, minimizing related impacts.

Keywords *Permeable areas, Protection of water resources, Sustainability*

1. Introduction

Water erosion is a process of soil degradation that can be caused either natural factors and by human interference, resulting in most often a process of accelerated erosion, bringing damages to the agricultural sector and the environment, as well as social and economical consequences. Aiming to maintain or increase agricultural productivity and environmental conservation, the soil erosion must be studied and understood, favoring sustainability as well. The infiltration process is of practical importance because it often determines the water balance in the rhizosphere and surface runoff, responsible for the phenomenon of erosion. Thus, knowledge of this process and its relationship to soil properties is of fundamental importance for the efficient management of soil and water (REICHARDT et al., 1996; apud PANACHUKI 2003).

Infiltration is defined as water entering the soil through soil-atmosphere interface. The term infiltration rate refers to the amount of water that crosses the unit area of soil surface per unit time. During the infiltration process and in initially dried soil, the infiltration rate tends to decrease with time, reaching a constant final value (LIBARDI, 1995; BERNARDO, 1995, apud PANACHUKI 2003). This constant value, called the infiltration rate, is an important attribute for the development of irrigation projects, drainage, soil conservation, and are essential in models used to describe water infiltration, and also in planning and management of irrigation systems, drainage and soil and water conservation.

Groundwater is part of the water cycle, so it is closely related to atmospheric processes and climate, rivers, lakes, sources and wetlands that underground water feed that reach the surface. All these sources are complementary to each other, but can be extremely varied, stretching from the arid areas till areas of high precipitation.

Soil physical properties can be changed by management practices and thus the water infiltration rate into the soil is modified, allowing increased runoff and accelerated soil loss changing the natural hydrological system (PANACHUKI 2003).

Considering the runoff, we can say that it starts when the rainfall becomes greater than the water infiltration rate into soil, or when the capacity of water retention by the soil surface has been exceeded. Associated with run off occurs transportation of soil particles, which undergo deposition only when its speed is reduced. In addition to the soil particles in suspension, are also transported nutrients, organic matter, seeds and agrochemicals, which besides causing direct losses to agricultural production and pollute watercourses (GRIEBELER et al., 2001).

Regarding the water resources sustainability, according to Pereira (2004), the constant population growth, and the resulting economic expansion, cause an increase in water demand because of the increase in the number of uses assigned to it, as the volume

required by each of these uses. Like this the problems notorious for deteriorating water quality due to pollution.

As demand for water grew up dramatically and the supply has not behaved the same way, its availability is almost constant. The rising urbanization, expansion of irrigated agriculture and industrial activities have caused a rise in demand for water in the world. Meanwhile, the supply has faced serious problems due wasted and accelerated degradation of freshwater supplies in the world. Despite the technological developments in the water resources exploration, the matching between demand and future supply is still far from having a formula of easy solution and neutral. It is known that many countries are already in shortage and still others are in alert state.

In Brazil, in particular this problem will be not absent in the future, knowing that this country has a tenth of the stocks of freshwater on the planet. Besides problem of environmental degradation, and Brazil has poor distribution of water in its territory, where 80% are in the Amazon region and remaining 20% are spread across the country to meet approximately 90% of the population. A major concern of technicians and water managers has been search of water allocation models that lead to a more efficient use. The Water Market has been suggested as a promising tool for allocation, several countries, has been verified the increased demand for water in recent years. Large water structures were built to meet this demand, at any cost do not be questioned if the water use would be effective or not.

The seek for a model of management water leading to greater efficiency and environmental preservation has been one of the biggest challenges. Nowadays, the water is considered as a scarce and with economic value. It is necessary in order to achieve more efficient allocation, and encourage conservation with techniques developed in economics into the field of water resources.

One mechanism able to be applied in cases of land use conflicts and water pollution can be quality targets for rivers in each watershed, according to their guidelines. In Brazil , CONAMA 357/05 Resolution, provides for the classification of water and environmental guidelines for its regulatory framework and sets out the conditions and standards for effluent discharge.

In Brazil, Law 9.433/97, which established the National Politic of Water Resources, defining that its sustainability depends on the availability of water, rational and integrated use, ensuring their quality for both present and future generations, the equitable access.

The practical importance of understanding the physical behavior of soil is associated with its use and appropriate management, in fact, irrigation, drainage, soil and water conservation. One of the most important physical properties, the soil porosity, is responsible for a set of

phenomena and develops a series of important mechanisms in the physics of soil, such as retention and water and air flow, and if examined together with the soil matrix, generates a group of other physical properties associated with the relations of mass and volume of the phases. A soil is physically ideal for plant growth when it has good water retention, good ventilation, good supply of heat and little resistance to root growth. In parallel, good aggregate stability and good water infiltration in soil physical conditions are important for environmental quality of ecosystems (REINERT, 2006). This way, this study aims to analyze and assess the role of green vegetation in the drainage from the Campus I of Passo Fundo University and to minimize the main related impacts, looking for sustainability of groundwater use by the University for the various purposes.

2. Methodology

The research was done in the Campus I, at Passo Fundo University, located in Passo Fundo, Rio Grande do Sul, Brazil. The experimental areas were chosen to identify possible differences in the characteristics of different land use (Figure 1), on soil classified as Oxisol typical according to (EMBRAPA, 2004.)

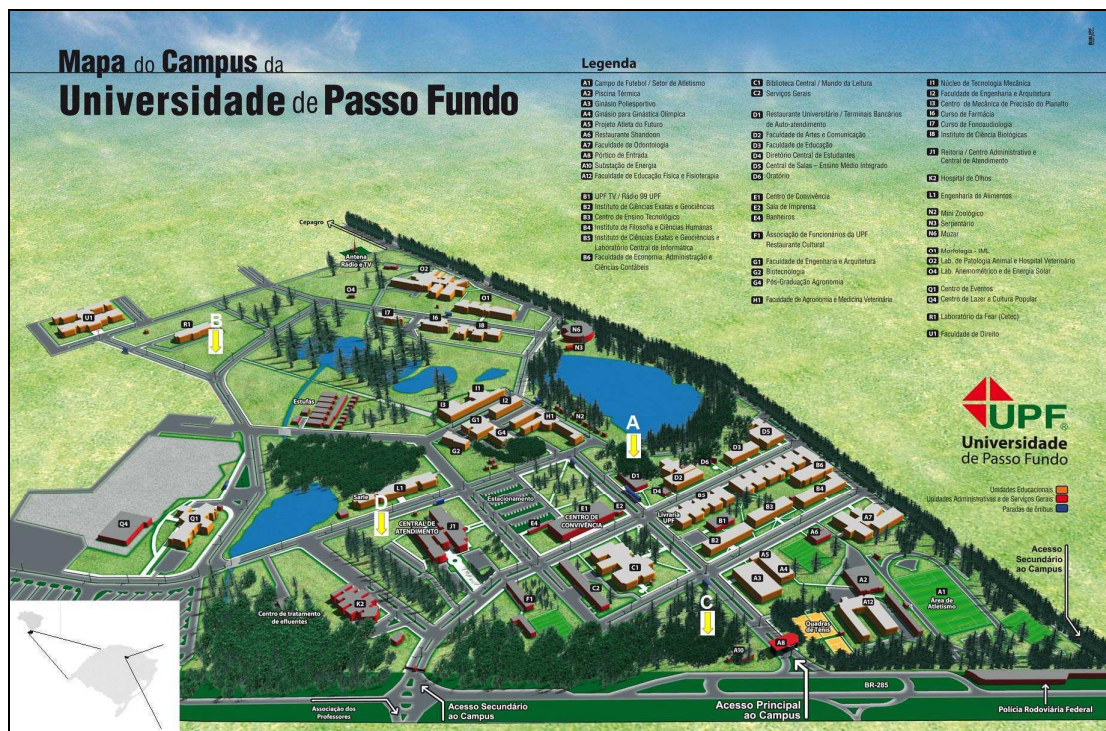


Figure 1 – Location of Campus I, Passo Fundo University (UPF) and experimental areas, Passo Fundo, Brazil.

The accord with Köppen's classification, Passo Fundo is located in the temperate climate zone (C), with temperate type fundamental humid (f) and specific variety subtropical (Cfa). For the testing of porosity and soil density, samples were collected at four different locations, and a depth of 0,3 meters collected from 5 by 5 cm. The choice of sites was performed by different types of vegetation exist, and they are completely without vegetation, covered with exotic forest, native forest cover and grass cover (Figure 2). The collection of soil was carried out on soil samples for each depth established in Uhland samplers, which have rings of known mass and volume. Soil samples were collected at six depths (0-0,05, 0,05-0,1, 0,1-0,15, 0,15-0,2, 0,2-0,25, 0,25-0,3 m). The sites of collection are illustrated in Figure 2.



Figure 2 - Illustration of the use systems sampled in the Campus I of UPF, Passo Fundo, 2010

The granulometry test was held according to NBR 7181/84 at a depth of 0.3 m.

Soil density, porosity, macro and micro porosity We collected undisturbed soil samples, using the volumetric ring centered, and analysed according to EMBRAPA, 1997.

The infiltration test was held according to NBR 7229/93 at a depth of 0,3 m.

The rainfall data in Passo Fundo - RS were obtained together Embrapa-Trigo which has a weather station.

The consumption data of groundwater were obtained from the administrative division of UPF. The University has eight wells to collect groundwater for consumption itself.

3. Results and discussions

3.1 Granulometry test

The particle size is one of the most important characteristics when related to the permeability of soil. The results of particle size in points analyzed are described in Table 1.

Table 1 – Size grain of land use systems, Passo Fundo, 2010.

Granulometry %	Native forest	Without vegetation	Exotic forest	Grass
Sand	51	31	36	44
Clay	39	60	54	46
Silt	10	9	10	10

The sand and clay are the main components of the Oxisols. The native forest was the system that obtained the largest percentage of sand and clay and the unique system that which surpassed. The other systems are all with high values of clay, classifying the soil are clay soils.

3.2 Soil Physical Characteristics

The data evaluated for the physical systems of land use are shown in Table 2. The density of the soil (D_s) expresses the relationship between the amount of soil dry mass per unit volume of soil. In the soil volume is included the volume of solid and porous soil. However, there will be change in the pore space change of D_s . The primary use of soil density as an indicator of compaction, as well as measuring changes in the structure and soil porosity. Normal values for sandy soils vary from 1,2 to 1,9 g.cm^{-3} , while clay soils have lower of 0,9 to 1,7 g.cm^{-3} . D_s values associated with the compression state with high probability of a risk of restriction to root growth are located around 1,65 g cm^{-3} for sandy soils and 1,45 g.cm^{-3} for clayey soils.

Lowest densities were found in layers 0-0,05 m, except in the soil discovered that impact of water drop rain influences permeability.

Porosity expressed space not occupied by solid and occupied by water and air that compose pore space, defined as the ratio of pore volume and total volume of soil. It is inversely proportional to D_s and great importance to direct root growth and movement of air, water and solutes in soil. Texture and structure of the soil account for most of the type, size,

quantity and continuity of pores. The most common classification of porosity refers to its size distribution. The most common is the classification of porosity in two classes: micro and macro porosity.

Table 2 - Characterization of porosity, density, macroporosity and microporosity at different depths in use systems, Passo Fundo, 2010.

Systems	Dephts (cm)	Porosity %	Densidty (g/cm ³)	Macroporosity	Microporosity
Native forest	0-5	51,7	1,268	0,173	0,184
	5-10	50,3	1,298	0,181	0,161
	10-15	49,4	1,358	0,145	0,167
	15-20	46,0	1,410	0,121	0,167
	20-25	50,3	1,341	0,150	0,177
	25-30	50,4	1,366	0,138	0,170
Without vegetation	0-5	29,6	0,981	0,096	0,088
	5-10	30,1	0,968	0,065	0,112
	10-15	51,5	1,367	0,048	0,173
	15-20	51,4	1,286	0,076	0,192
	20-25	51,9	1,273	0,096	0,177
	25-30	51,3	1,271	0,073	0,193
Exotic forest	0-5	61,6	1,029	0,213	0,219
	5-10	55,6	1,172	0,190	0,164
	10-15	53,3	1,237	0,156	0,162
	15-20	53,6	1,229	0,153	0,169
	20-25	55,8	1,171	0,174	0,369
	25-30	55,3	1,182	0,162	0,186
Grass	0-5	52	1,272	0,122	0,207
	5-10	43,3	1,501	0,069	0,139
	10-15	42,2	1,531	0,044	0,148
	15-20	39,3	1,609	0,052	0,099
	20-25	42,1	1,535	0,048	0,143
	25-30	46,3	1,423	0,086	0,164

The microporosity is a class of pore size which, after being saturated in water, retain it against gravity. The macropores, instead, after being saturated in water does not retain it, or

are emptied by gravity. Total porosity was determined by the difference in mass of soil saturated by the mass of dry soil in a oven.

The efficiency vegetation cover in reducing soil losses can be attributed mainly to protect the soil surface provided by the plants, preventing the direct impact of raindrops on the surface, reducing soil degradation and resulting in low sediment concentration in runoff. Moreover, in plants presence, large amounts of water are sweaty, reducing soil moisture, thus increasing the rate of water infiltration into the soil reducing runoff volume, reducing the tendency to soil crusting, and increase surface roughness, slowing runoff and consequently its erodibility (DEDECEK et al. 1986; SEGANFREDO et al., 1997).

The infiltration coefficients obtained were 88 L/m²/Day in native forest soil, 60L/m²/Day without vegetation soil, 77 L/m²/Day soil with eucalyptus and 75 L/m²/Day soil with grass. The two highest permeability was obtained from the exotic forest and native forest soil, because the presence of vegetation the ground better with structure, facilitating the infiltration. The soil without vegetation showed lowest permeability, it is more compressed and do not have root systems that serve as the preferred route for water. The total consumption of underground water on campus I University of Passo Fundo is distributed in eight wells located in different places on campus (Figure 3).

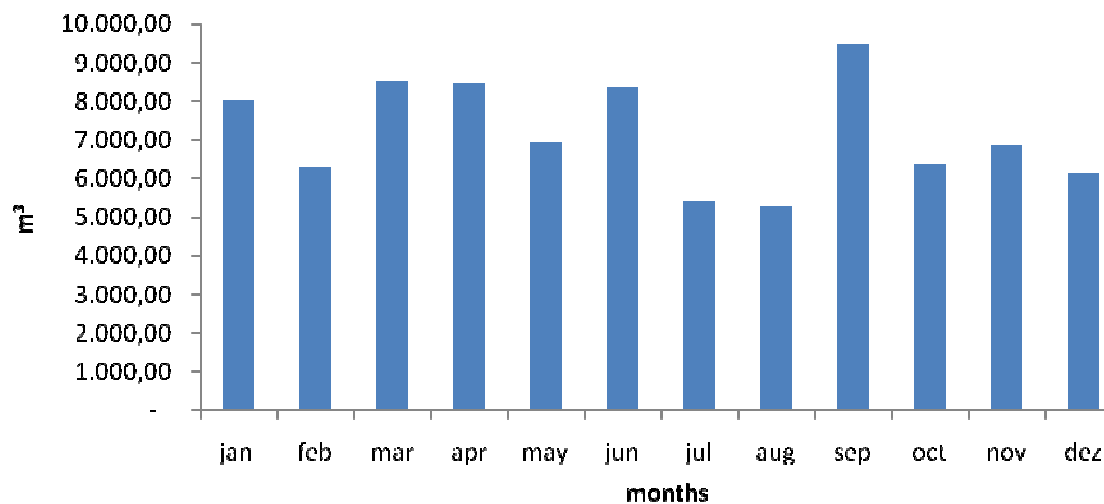


Figure 3 - Water consumption during the year 2009.

In July and August there is a lower consumption of water because is a season with lower temperatures and also a period of school recess. September was the month with higher

consumption due to higher number of events focusing a temporary public of the region, besides the increase in the number of academics.

Observe an increase demand for water in recent years, so large water structures were built to meet demand at any cost, while not questioning whether water use is sustainable or not. The search for model management water leading to greater efficiency and environmental preservation has been one of biggest challenges. The water is now treated scarce and with economic value, highlighting the importance of this natural resource, environmental sustainability coupled with economic development, seeking minimize the impacts of improving the drainage rain water infiltration contributing to groundwater recharge.

The UPF Campus I soil has several uses favoring drainage and supply of groundwater, it contributes to the natural hydrological cycle, which ends replenishing underground water, leaving no place to lowering the water table and consequently the lowering of the ground.

4. Final considerations

Passo Fundo University has a crucial function in disseminating responsibility and expertise with such issues of sustainability, stands out with regard to land use, planning the construction using sustainable materials with minimal impermeable areas so reduce the impacts on drainage, worrying about the correct handling green areas of Campus I, thus favoring a better permeability of water in the soil.

With results obtained in the research we realize that land use is important factor influencing the drainage. A soil with a greater diversity of species has higher and better conditions water infiltrate emphasized the importance of green areas in urbanized locations. The UPF consumes too much water from underground so the importance of recharge areas and infiltration within the institution itself looking for water resources sustainability.

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