

ASSESSMENT OF RISKS DUE TO METEOROLOGICAL PHENOMENA AND ANTROPIC ACTIVITIES IN THE TROTUS RIVER BASIN (CASE STUDY IN BACAU COUNTY)

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Specialists of the International Institute for Climate Study have warned that year 2005 had been the warmest since the history of the thermometer on planet EARTH and had offered the most varied, extensive and numerous mass of events called “climatic catastrophes”, with the highest number of deceased and the greatest material losses. Year 2005 will not be “an exceptional one” at global level and by all means not in the Trotus River basin. There will be other years exceeding 2005 including Bacau County and the Trotus River basin.

This is why an ecological reconstruction on the affected and assessed areas would be extremely costly and pointless, before the implementation of effective prognostic methods and of methods that would arrest and preserve the existing unaffected patrimony, a patrimony which could easily be affected by the climatic and antropic evolution of the coming years.

Taking the current situation as a starting point (the data bases) and according to the project management, there is an absolute need to carry out “detailed analyses” of the evolution of climatic and antropic phenomena, in order to be able to prognosticate and establish the dimension of management measures to be implemented so as to CREATE A SUSTAINABLE AREA.

Keywords: hydrographic basin, risks, ecosystems, areas, precipitations

1. INTRODUCTION

Assessment is a tool of decision making for the implementation of all major projects, and in the Trotus River basin it is also necessary to design and implement a project on “The regulation of slopes, of creeks and of the Trotus River through civil engineering works and land melioration, to be followed by a second project for the ecological reconstruction of the natural areas in the North and of agricultural areas in the South”. When assessing the impact of this project on the environment of the area the following questions need to be answered:

- May this project be carried out and become operational under safe conditions? Without a major risk engendering new accidents that would endanger ecosystems and human lives. We refer mainly to the possibility to build retention basins and hydroelectric power stations which would entail the altering of the landscape.
- Would there be conflict between the location of the project and the current land-uses or would it thwart later developments in the area? It is important to mention that the sustainability of the area and the increase of the quality of life of the inhabitants may be achieved only under strict rules of environment preservation and development. In their absence and with major climatic, hydro-technical and economic-ecological risks, sustainable development is practically impossible. Owners of forests must understand that the “status of owner” does not preclude law enforcement. Local authorities have the obligation to keep watch on law enforcement and to arrest abusive deforestation. Should this requirement not be fulfilled no progress is possible! What alterations of ecosystems could this project bring about? There could be some, as the unpolluted areas might be reduced in the region of artificial lakes. Those would be replaced by water works.
- Risk R may be calculated according to the following formula:

(1) $R = F \times C$ in which:

R = risk (loss of soil and rock in tons/year, loss of crops, biomass and human lives etc.)

C = quantity of losses/event (foods, landslides etc.)

F = frequency of events.

Losses may include also forest areas, where abusive quantities of wood cuttings and sales that occur, if effective measures would not be taken to arrest those actions.

2. ASSESSMENT OF RISKS

2.1. It is known that in 2005 all possibly envisaged quantities of precipitations were exceeded

2.2. Year 2004 was one in which precipitations of more than 70 mm in 24 hours have fallen in at least seven of the Trotus subbasins – in the Palance Goiosa area. Damages incurred in 2004 amounted to three deceased individuals and 2.2 million euro.

In year 2004 we received an important signal, which became 20 times amplified in 2005. The signal of 2004 had been overlooked and its consequences became obvious in 2005. Therefore what is to be expected in the future?



Fig. 1 After the catastrophes of 2005, almost 3,000 frame-saws were inventoried which contributed to the destruction of forests. In the future, monitoring their activity as by law should become mandatory for local authorities.

To answer the above question it is necessary to monitor the main components of the risk generated by meteorological conditions and the geo-morphologic characteristics of soil and relief (Fig.2). It is obvious that the major environment risks are related to flooding. If we attach the value of losses to risk (Risk value losses R_{vl} in their value expression or R_m material risk t / deposits transported)

(2) $R_{vl} = f(P)$; P = precipitations i.e.

$R_{vl} = a + b \times P$ in which

a = normal quantities of precipitations in the area

b = correction factor of the regression function

A careful look at the evolution of losses shows that they remain linear up to 15 mm of precipitations in 24 hours and from then on become logarithmic or squared, that is:

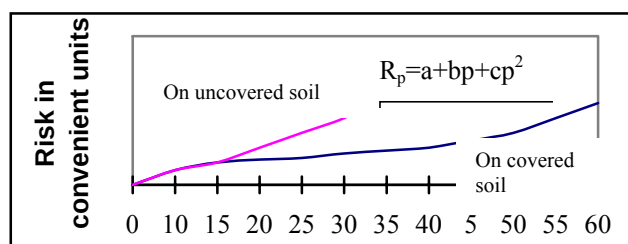


Fig. 2. Various models of evolution towards catastrophe due to heavy precipitations in relation to the degree of soil-covering by vegetation

The volume of fallen precipitations is directly influenced by climatic conditions and indirectly by antropic activities. The natural status of the territory S_{nt} at moment $(T - 15)$ ($2005 - 15 = 1990$) did not offer risks as those in 2004 and even less than in 2005. “ S_n ” opens up to risk conditions due to the shape, position of slopes and the geology of the relief. As we mentioned, “ S_n ” in the Trotus Valley is bound to catastrophes when antropic activities relatively slightly disturb ecological laws in this particular ecological construction. We hope, that in order to implement the major project we proposed, specialized research would study the innermost causes of this natural vulnerability and the restricted space in which antropic activities might disturb ecosystems (Fig. 3).

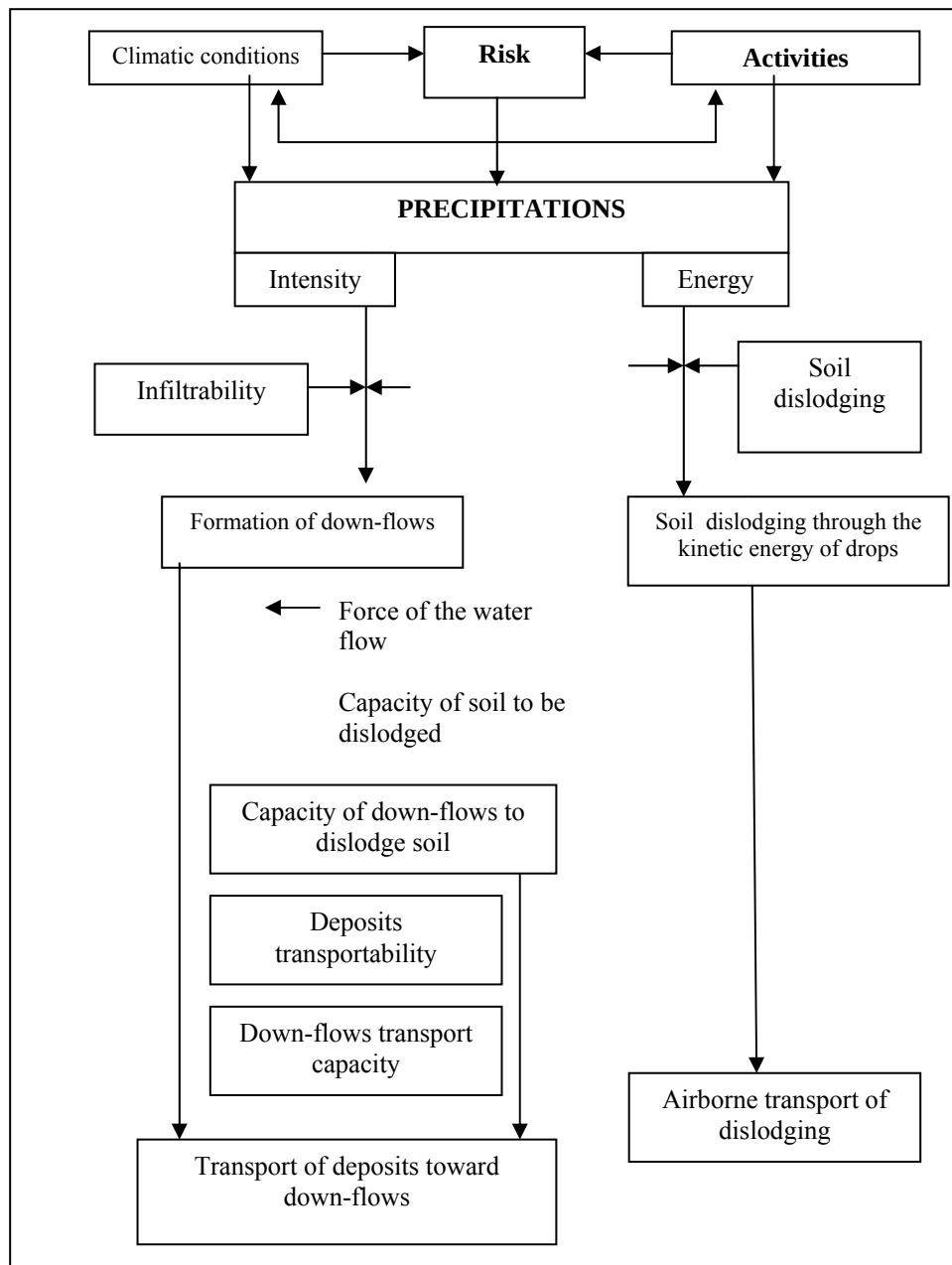


Fig. 3 Factors necessary to assess flood risk in the Trotus Valley

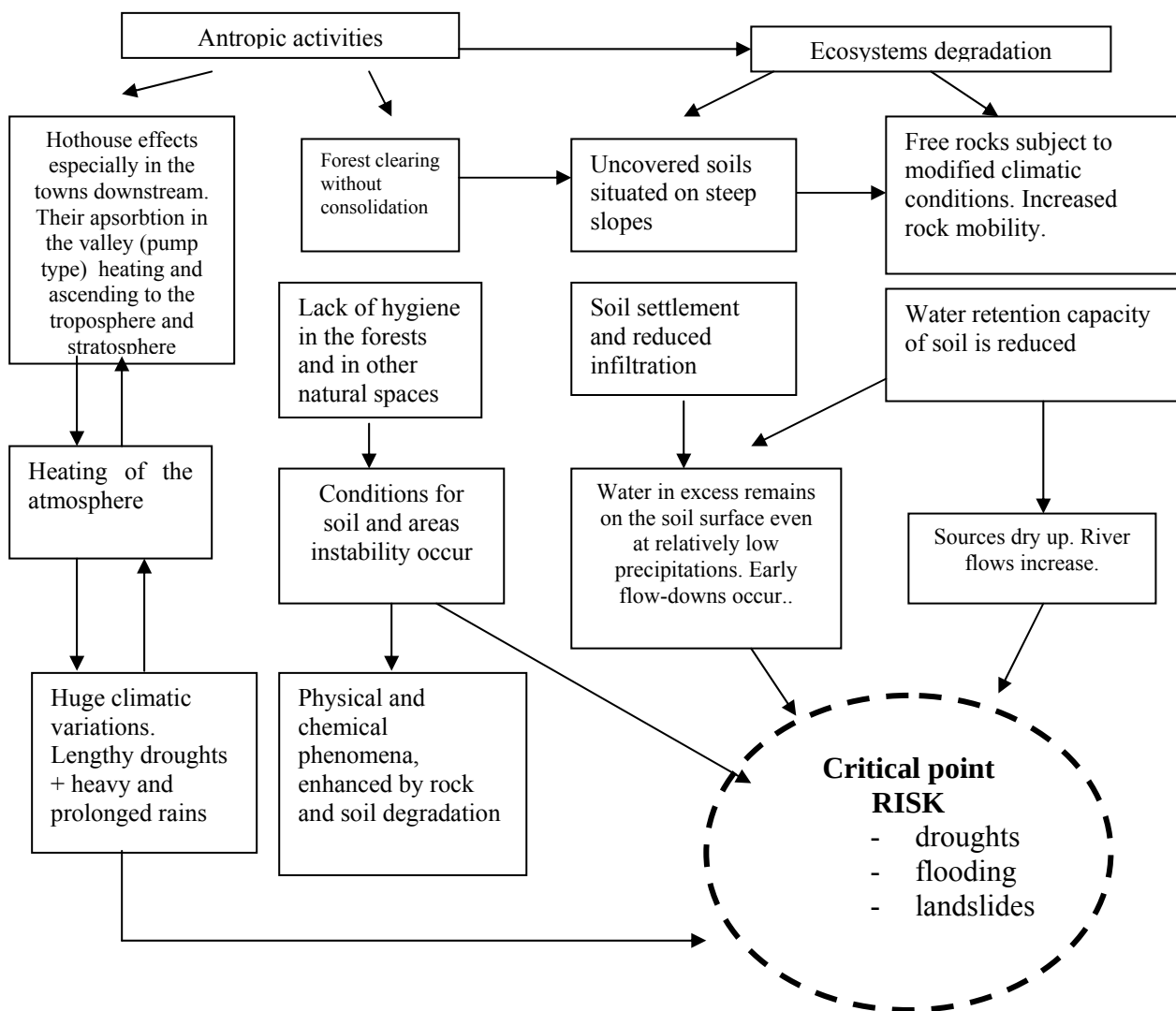


Fig. 4 Risk inducing events in the Trotus Valley

The sequence of events leading to risk is the following:

- a) **Heating up of the atmosphere** originates from various directions that need careful studying:
 - Local gas emissions (industrial plants in the area)
 - Pollution imported to the area
 - Intense phenomena of biological activity at soil level for the biological degradation of waste from the un-hygenized forest areas: methane +CO₂+NO₂+NH₄ etc.
 - Reduced gas absorption or retention by the forests and the degraded soil.

Heating of the atmosphere will be a long-term phenomenon even if the emissions and their transfer to the stratosphere would come to a halt; dissipation of gases that created a “compact bed” up there at over 20 km would take at least 40-50 years. There is no technological solution as yet to eliminate gases from the stratosphere. The hothouse effect brings about profound changes in the local ecosystems, reducing their stability, sustainability and functionality.

b) **Current state of the forests** which is an ample and important issue. As already stated, the phenomenon exists and is there to stay in the Trotus Valley. Forest clearing proceeds at an unprecedented rate and without taking into consideration the impact of this action, which might be called criminal, on the natural state “ S_n ” of the basin. “ S_n ” has evolved in “ S_c ” (current state). “ S_c ” has the following characteristics:

- Gradual decrease in successive stages of forest areas in the basin, up to 20%.
- Wood cutting in the most vulnerable areas, triggering immediate phenomena of erosion, down-flows, transport and deposit hoarding up.
- Excessive thinning out of forests especially in the watershed areas, unleashing negative phenomena such as erosions and downward slides. Isolating groups of trees as retention curtains would only postpone the evolution of these phenomena towards the same kind of degradation. The phenomenon may be best illustrated by the fact that in 2005 after the catastrophe there were 3,000 frame saws inventoried in the Trotus Valley, most of which operating illegally, which illustrates the lack of anticipatory thinking and interest for the preservation of natural areas of local authorities.
- Huge quantities of saw dust and other organic and mineral wastes contributed to the blocking of the river bed and to geological changes.
- Wood cutting in the backyards of houses situated along the river was one of the most destructive activity of local people, as it lead after several years of such cuttings to the displacement of the mountain into the river bed, thus destroying the living environment of those who knowingly or unknowingly perpetrated those activities.

c) **The current state of soil and geology** can be divided in two segments, namely:

- Alluvial soil in below-mountain areas, hills and planes, consisting of fine and very fine components depending on the nature of silt and the frequency of large floods. With the exception of the settled upper crust, all these soils are soft irrespective to their taxonomic category.

Grey soils in the high hills and those under forests, clay-erratic soil and brown-podzol are settled or partially settled. There are also rock-soils and rocks located mainly in higher areas. Both soils in the planes and those on the hills and mountains were in an advanced state of settling at point T2005, in other words both the infiltration and the water accumulation indexes were very low. This kind of soils reduce severely both filtrated and infiltrated water, contributing decisively to the increase of flows on the surface (Fig. 5).

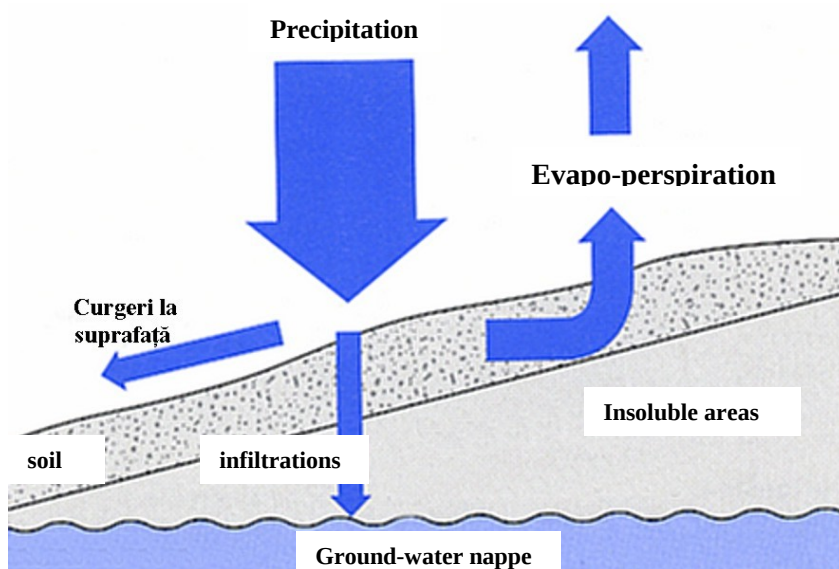


Fig. 5 –Distribution of water from precipitations depending on the geo-morphological and climatic parameters (Berca, M., 2006)

The infiltration factor seems to be determinant when computing flood induced flows. This factor (C_f) results from the following relation:

$$C_f = \frac{Q_{\text{inf}}}{Q_{\text{prec}}} = \frac{\text{Volume of infiltrated water l/m}^2}{\text{Volume of water from precipitations l/m}^2}$$

As the volume of infiltrated water is smaller than the volume of precipitations, it is obvious that it is $<1(0-1)$. When the terrain is plane and water is bogging on the surface for a certain time, at a height of “h”, hydraulic pressure given by “sh” might increase the volume of infiltrated water, especially on soils with a near “normal” settling rate. As this condition was not fulfilled in the Trotus Valley, events had a different development. Consequently, the volume of water flow-down is the difference between the total fallen water quantity from precipitations Q_p and the infiltrated water Q_i additioned by potential evapo-perspiration E_{vp} .

$$\text{I.e. } Q_{fd} = Q_p - (Q_i + E_{vp})$$

Especially after the soil being saturated with water $Q_i \rightarrow 0$ and E_{vp} would have been insignificant in relation to the huge volume of fallen precipitations. So it can be stated that $Q_{fd} \leq Q_p$.

What was the significance of the above for Bacau County? Let us consider only July 2005, a month in which the greatest rush of water had been registered on the Trotus (maximum flow $3,000 \text{ m}^3/\text{s}$). How this devastating flow was created? We present below some calculations.

Surface area of the Trotus $\approx 300,000 \text{ ha}$

Precipitations fallen = $220 \text{ mm} = 2,200 \text{ m}^3/\text{ha}$

Infiltration = $18 \text{ m}^3/\text{ha}$

$E_{vp} = 20 \text{ m}^3/\text{ha}$

Available water $2,162 \text{ m}^3/\text{ha}$

Total water available in the Trotus basin: $300,000 \text{ ha} \times 2,162 \text{ m}^3/\text{ha} = 648,600,000 \text{ m}^3$ of water. Had this quantity of water been uniformly distributed on the whole area of the basin, its height would have been of 22 cm or 0.2 m . But as there are no plane surfaces in the Trotus basin, down-flows on the slopes were created for the evacuation of this water, which were as higher as D_h (hydrostatic difference) was greater due to the huge volume of precipitations. Had the precipitations fallen uniformly during the whole month, the volume of flow-downs would have been: $648,600,000 : 2,590,400 \text{ seconds} = 250 \text{ m}^3/\text{second}$, which would have been bearable. Actually the imbued soils received up to $80 \text{ mm}/24 \text{ hours}$, leading to:

$300,000 \times 800 \text{ m}^3/\text{ha} = 240,000,000 \text{ m}^3/\text{day}$

$240,000,000 : 86,400 \text{ seconds} = 2,780 \text{ m}^3/\text{second}$,

i.e. very close to the figure registered on the Trotus on 13-14 July 2005.

Our calculations had a deviation of only 0.7% from the actual measurements made at Vranceni and consequently may be taken as specifications for any projects necessary to the regulation of the basin.

3. CONCLUSION

Large quantities of water flowing down at high speed on slopes trigger implicitly an erosion process. According to our assessments, each cubic meter of water on its way down the slope and also during rain fall has dislodged and transported about 0.5 m^3 of rock and organic and mineral sediments of various dimensions. It means that solely the water rush of 13-14 July 2005 had carried over 120 million m^3 of material that settled on the slopes

and in the riverbed, the coarsest ones, and the finer ones under the hills, in the planes and the finest in the Siret inclusively.

During the whole year, the Trotus has carried over 300 millions of m³ of organic and mineral dislodged materials, altering the whole geography of the geology and architecture of the biomass in the area and creating the pre-conditions for accelerated and lasting damages in the basin, if no correct measures would be taken to stabilize the areas and regulate the creeks and rivers for an overall ecological reconstruction.

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