THE „BABEŞ – BOLYAI" UNIVERSITY CLUJ-NAPOCA
THE FACULTY OF GEOGRAPHY
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RISKS INDUCED BY EXCESS WATER IN THE SOMES PLAIN

PhD Thesis abstract

Key Words: Somes Plain, water resources, water excess, hydric risks, flooding, water balance, damage, draining, dams and canals

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TABLE OF CONTENTS

INTRODUCTION

Worldwide and for our country as well, risky hydrologic phenomena are the current topic of many scientific meetings, as they affect not only the features of the geographic environment but also the human society, a well-known phenomenon being the floods over the past decades, which, until further land improvement (hydro amelioration, draining, embankment, etc.) produced important material damage but most important, human losses.

The research topic with the title „Risks Induced by Excess Water in The Somes Plain” has been chosen as it was desired to elaborate a long, unitary and complete thesis which would analyse the risk phenomena induced by the water surplus all over the Somes Plain, this being highly topical as it has not been approached in whole by researchers from this point of view, only partially, on regional level.

The study has porposed, initially, the elucidation of the elements of territorial unit and regional subordination of Somes Plain, the explanation of the proper terminology for the study together with the methodological aspects regarding the evaluation of the water surplus, the factors (actors) involved in determining this process, further coming the most important part, namely the result of the research, following which the final goal has been reached, that of the demarcation of natural hazard areas by drawing floods risk maps, immediate intervention priorities for preventing and diminshing the consequences, the elaboration of a proper monitoring system, the formulation of certain action programmes for ecological reconstruction of the environment.

The research methodology has focused on three directions: the documentation and the collection of information material stage (documentary-descriptive character), the research on the field stage and the interpretation, processing and rendering of observations, analysis, measurements and determinations carried out stage. Thus, the research involved exploring the area first, followed by establishing the analysis period and the institutions supplying data, terrain mapping, water measurements done together with experts from Satu Mare Water Management System, taking pictures of collection and taking points of water and meteorological data, of marshland areas, of land improvements works. Subsequently, the office stage began, where numerous raw data were adopted (discharges, levels, rainfall, flash floods, drilling, canals, accumulation, etc.) followed by data processing in order to obtain a water balance of the plain, the cause of water surplus. The results allowed the highlight and evaluation of the risk induced by this phenomenon (floods, soil water surplus, marshes, pollution of groundwater, habitat structure modifications), risk monitoring and management based on water risk maps, justification of the proirities and target investments for the protection and reduction of the risk to which the population, the infrastructure and the environment may be subjected. Furthermore, prevention and combat measures against effects induced by the stationary water phenomena and processes on Somes Plain were highlighted, by both structural and non-structural work (the perception of stationary water phenomena and processes on a sample, on both sides of the Somes Valley, superimposed on the plain).

The thesis is structured as follows: 6 chapters comprising 318 pages, 75 tables, 93 figures, 231 national and international bibliographic titles.

1. ELEMENTS OF TERRITORIAL UNIT AND REGIONAL SUBORDINATION

1.1. GEOGRAPHIC LOCATION, LIMITS AND FEATURES OF SOMES PLAIN

Geographic location – Somes Plain is located in the north-western part of the country, representing the northern subunit of the Western Plain, occupying an area of over 3600 km2 with 100-220 m elevation. An almost exclusive creation of the inferior parts of Somes river (together with its present and former tributaries – Tur, Homorod, Crasna, etc.), Somes Plain is bordered, towards the east, by the eruptive heights of Oas-Gutai Mountains, with which it connects by the means of narrow strips of glacis (north of the Somes river) and by Silvania Hills respectively (south of Somes river). Entering under the form of extensions towards the Oas Basin (in the north-east), the Baia Mare Basin (in the east), the Crasna Basin (in the south) is the result of the different conditions under which they formed and also of the influences exerted by the higher neighbouring units (**fig 2**).

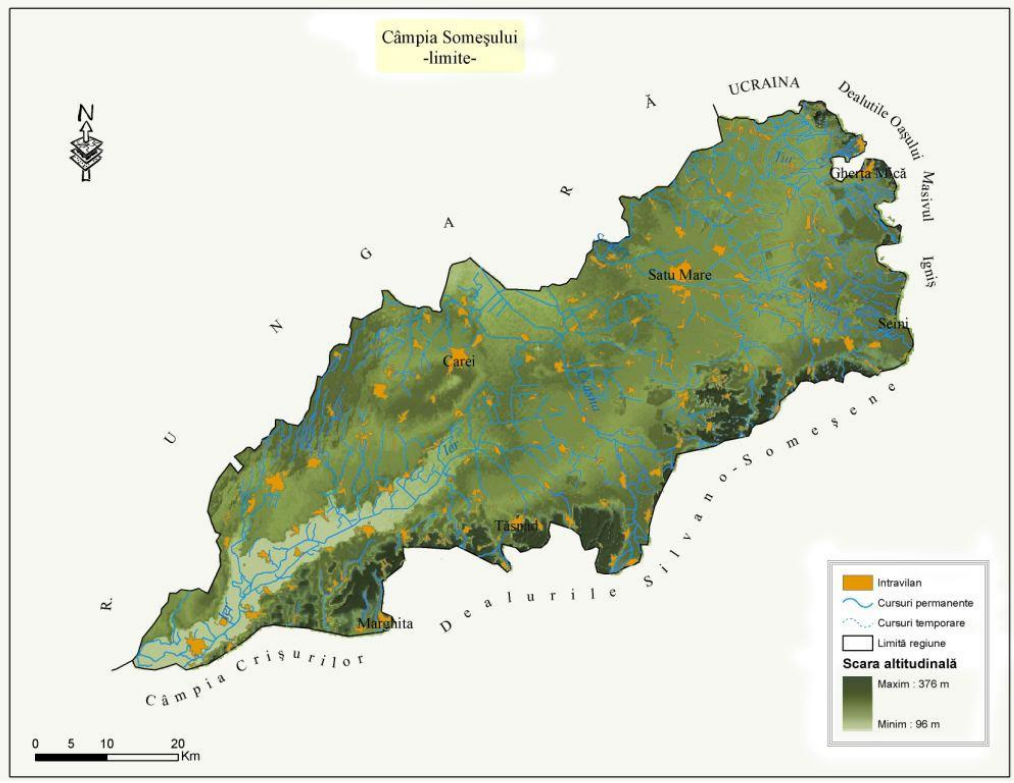


Fig. 2. The limits of Somes Plain (Gr. Posea, 1997)

Therefore, the **Somes Plain** corresponds to the territory formed and drained by the river Somes and surrounding valleys, bordered by Oas Hills (Halmeu-Vii, Turulung-Vii, Prilog-Vii, Medies-Vii, Orasu Nou-Vii, Racsa-Vii, Viile Apei and Seini localities area), towards the east, by the Silvano-Somes Hills (Seini, Crucişor, Sâi, Tătăreşti, Viile Satu Mare, Ardud, Răteşti, Beltiug, Săcăşeni and Tăşnad) and the Cris Rivers Plain, to the south (between Tăşnad and Diosig), and to the west the limit following the state border (Gr.Pop 2005).

The **Somes Plain** alligns to 115-130m low plains category on most of its area (115 north of Berveni), on small areas, in high sectors, reaching approximately 170m (171 m west of Sâi), having a slight slope from north to south (130m in Halmeu, 110 m in Sacuieni). Such high altitudes can be seen on Carei-Valea lui Mihai sandy plain because of the dunes (155 m north-west of Curtuişeni, 160 m north of Scărişoara Nouă).

The entire territory of the plain is covered by Quaternary formations (gravels, sands and mud) which meet the Neogene migmatites of the Oas Hills, Pleşcuţa (364 m), Turulung-Vii (396 m), Jelejnic (480 m) and Spatele Dealului (346 m) respectively. Towards the Silvano-Somes Hills these meet the Pannonian formations.

The Somes Plain presents some characteristic features which differetiates it with respect to the rest of the plain. These features were determined by the specific genetic conditions which were created by its close basin shape whose surface waters had difficult and uncertain flow possibilities towards the inside of the Pannonian basin because of the interposition of the higher area of the Nir Plain.

The unit, with low altitudes over the most part of its area, crossed by the rivers Somes, Tur, Crasna, Ier, rivers which have their beds modestly shaped and discharges among the highest for large rivers, these recording, in order, in 1970, about 3400 m3/s (Satu Mare), 565 m3/s (Turulung), 575 m3/s (Moftinu Mic) and 542 m3/s (Săcuieni), as opposed to regular discharges of 114 m³/s, 8.80 m³/s, 5.23 m³/s and 6.72 m³/s (**Geography of Romania, IV, 1992, p.100**), was always characterised by quite frequent overflows and by the presence of muddy areas. Henceforth, the plain was subjected to a series of hydro-ameliorative works: embankment of main rivers, digging drainage canals in areas with excessive humidity (Crasna and Ier) or collecting waters streaming down the hills area (Homorodu Nou, by directing the waters of the upper reaches of river Homorod towards river Somes, whereas the lower reaches kept their old way through Ecedea Plain).

1.2. ELEMENTS OF REGIONAL SUBORDINATION IN THE GEOGRAPHIC AREA

The microregioning of Somes Plain was made upon a complex criterion, taking into consideration several elements of the geographic landscape which give the physical-geographical characteristic trait to different units. In associating certain land areas into smaller physical-geographical units, were taken into consideration the lithological characters which can be: alluvial fan flooding or piedmont alluvial fan (large alluvial fans and long colluvial glacis), sandy, marsh muddy, etc.

At the same time, the presence and the characters of the dominant micro-relief forms, or their absence (small mounds, long crests, abandoned valleys and meander loops, sand dunes, etc.), the nature of the soils in relation to mother rock (alluvial, claylike, sandy, coal, etc.), the conditions of natural drainage of surface waters (slight drainage, high drainage, semi-drainage or no local drainage) and the groundwaters (depth of the hydrostatic level and its variations) were noticed (A. Bogdan, 1957), (Gr. Posea, 1997).

The Somes Plain is composed of five subcolinar plains (Ardud and Tăşnad with glacis and terrace character, Buduslău and Pir with low plateau character, glacis shaped on valleys), a piemontan –tabular plain with loess and aeolian sand (Carei-Valea lui Mihai) and two digression plains (The Somes Lower Plain and the Ier Plain).

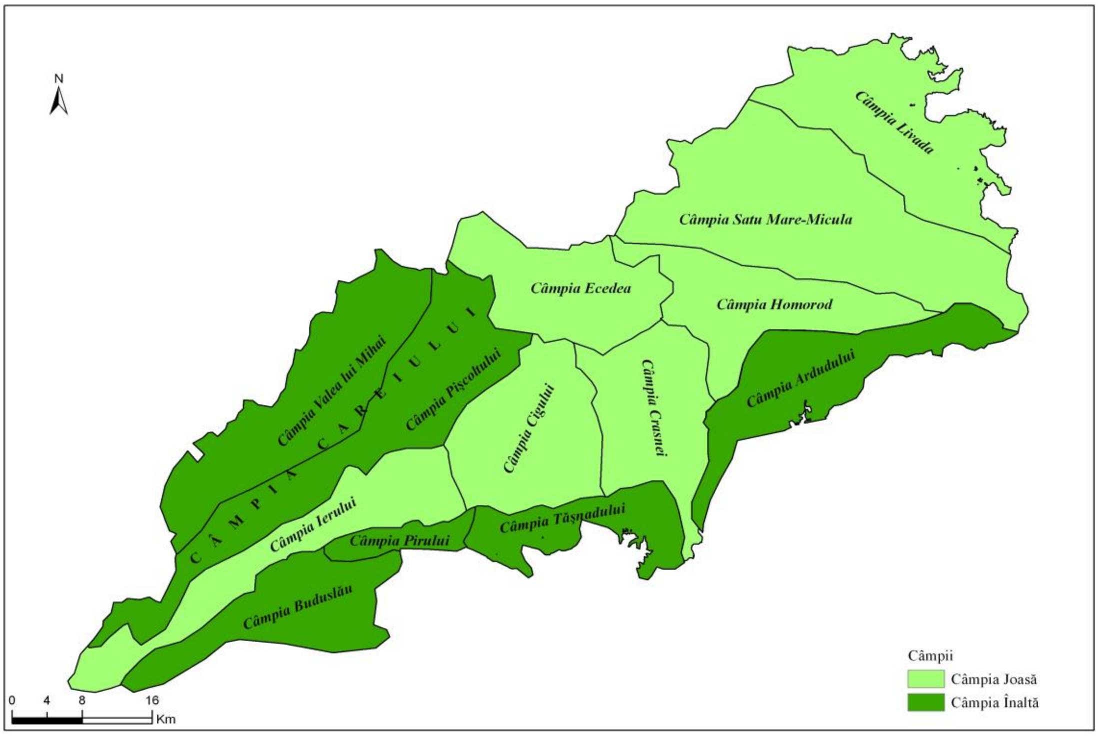


Fig. 5. Subdivisions of the Somes Plain (Grigore Posea, 1997)

1.2.1. The High Plain

A continuous strip of glacis unfolds at the border between the Silvania Hills and the Somes Plain, with widths varying between 3 and 15 km, occupying a surface of about 560 km2 which form a high step of the Somes Plain. All along its more than 100 km, the relief fragmented by the rivers Homorod, Crasna, Ier and their tributaries presents shape associations, either with slow passage , under the form of trains such as in the areas of Crucisor - Ardud - Beltiug and Acâş - Tăşnad – Sălacea, or with steeper slopes between Beltiug and Dobra and Sălacea – Diosig. (fig.5)

1.2.2. The Lower Plain

It is the widest unit of the Somes Plain sub-regions, occupying a flat surface of about 1800 km2, slightly aslope towards the north west, being at the same time the highest western lower plain being 20-30 m higher than Timis and Cris Rivers plains. It extends on both sides of the river Somes, occupying the entire right side plain up to the volcanic hills and on the left side it limits to the glacis of Ardud Plain and the river Crasna. The subdivisions of the plain graft mostly on the oldness and elevation of the surfaces and on the alluvial intake of different rivers. A certain discontinuity is found in the Somes Valley, thus resulting two great sub-units: the Lower Somes Plain and the Ier Plain. North of Somes there are two plains (the Livada Plain and the Micula Plain) and to the south there are other two (the Crasna-Homorod Plain and the Ecedea Plain), these four being part of the Lower Somes Plain, to which the Ier Plain adds, superposed over the corridor created by this river.

2. THE NAME AND HISTORY OF THE RESEARCH IN SOMEȘ PLAIN

There have been written numerous studies of Physical, Human and Economical Geography on Someș Plain, which have sometimes targeted only some parts of this territory, and some other times the entire surface or even more extended areas, referring either to Tissa Plain, or to the Pannonian Basin or the West Plain of Romania. Thus, in a chronological hierarchy, the first scientific mentioning appeared in 1923 in the paper entitled: ***"Contributions to the Study of Tisa Plain".*** The next ones are some tangent studies of **R. Ficheux** (1929), and for the geography of the population and settlements the works of **St. Manciulea** (1931) and **L. Somesan** (1938, 1939) are worth mentioning.

Beginning from 1952-1953, there began a systematic mapping of the Someș Plain, as a natural necessity to know this area, in order to start hydroameliorative works. With respect to this, it is worth pointing out the synthesis studies of several authors like: **M. Pauca**, who wrote about the Western Neogene (1954), the synthesis from "**The Geographical Monograph of the Popular Romanian Republic**" (1961), or the syntheses of **V. Mihăilescu** (1966), **P. Coteț** and others (1967), with a geomorphological map of Tisa Plain, to which we can add **A. Bogdan**'s studies for "Someș Plain" (1957, 1960, etc.), **Al. Savu** (1958) with a regionalization of the plain, etc. A more profound approach to the Someș Plain was made in 1966 by **Vintilă Mihăilescu** in his work "**Romania's Hills and Plains"** , published by the Scientific Publishing House in Bucharest.

With a contribution to the elucidation of some geographical issues in Someș Plain, there are several more recent and more complex synthesis studies made by **Grigor Pop ("*The Western Hills and the Western Plain*"), Grigore Posea ("*The Western Plain of Romania*"), Gheorghe Iacob ("*General Features. Someș High Plain and Low Plain*"** in Romanian Geography, volume IV), **Alexandru Savu ("*General Features of Someș Plain*"** in Romanian Geography, volume IV), **Csaba Miklóș Kovács ("*The Geography of Agriculture in Somes Plain*"), Cocean Pompei ("*Landscaping Plan of the Northwest Region*** (PATR) and "***Economical and Social Development Strategy of Micro Region Tăşnad***"), **Basarab Victor Driga ("*Natural Risks in Satu Mare County*") and Grigore Vasile Herman ("*Man and Anthropogenic Changes in Someș Plain*").**

Other studies, like ***the geological and hydrogeological study*** of Someș Plain have been made by authors like **N. Oncescu**, **T. Bandrabur**, **R. Ianc**, **Zoltan Benedek** and others.

Due to some conjectural factors, like the geology and the relief, Someș Plain has been exposed for a long time to floods and water stagnations on the surface of agricultural terrains. In order to limit these drawbacks, a series of hydroameliorative works have been made. These were described in detail by **V. Blidaru**, **P. Georgescu**, **I.M. Gheorghiu** and **D. Vlădescu**, in 1962, in their paper ***„Hydroameliorations in R.S.R. Monograph"***, published by the Agro-Silvic Publishing House, Bucharest.

From a ***morphological and geomorphological*** point of view, Someș Plain has been studied by **Ignatie Berindei**, **Petre Coteț**, **Alexandru Roșu**, **Grigore Posea**, **Mihai Ielenicz**, **Ioan-Aurel Irimuș**, **Ion Mac** etc. Moreover, a very important study, from a geomorphological point of view, is **Nicolae Josan**'s study – **"Ier Plain – Geomorphological Description**", published in 1992 in the Annals of Oradea University, Fasc. Geography. This was followed by studies of ***climatology*** (**Sterie Ciulache**, **Carmen Dragotă** etc.), ***hidrology*** (**Iuliu Buta**, **Victor Sorocovschi, Iosif Ujvari, Petre Gâștescu, Alexandru Cineti, Constantin Diaconu, Carol Karácsonyi** etc.).

3. METODOLOGICAL ASPECTS REGARDING THE EVALUATION OF THE WATER EXCESS

3.1. DEFINITION AND CLASSIFICATION OF THE WATER EXCESS CONCEPT

According to DEX, second edition, Bucharest 1998, the term „excess" is defined as follows: *„...the quantity which exceeds a certain limit, which is left after meeting all the needs; surplus, abundance..."* The term de „*exceeding*", refers to: „*...something which is in excess, which exceeds a certain level or a certain pre-established limit...*".

Thus, *„water excess" – represents the water surplus, resulted in the hydric balance sheet, through the analysis of each individual parameter (rainfall, runoff, evapotranspiration, complete soil moistening) to which it is added allochthonous water intake, resulted from the slopes surrounding the plain (the studied area).*

3.2. METHODS OF EVALUATION OF THE WATER EXCESS

The evaluation of the water excess can be done through several methods which take into account the limit thresholds, according to which the degrees of risk caused by these can be calculated.

3.2.2.1. The method of the hydric balance sheet

For the description and quantitative expression of the water circuit in the general geosystem, one can use broadly mathematical models of the balance equations. These models are attempts to describe, analyse, simplify or express the system, which is assumed to exist in the real world and to possess unique features. The forms of water excess manifestation can be: of *ponding* at the surface of the ground and of *soaking* in the soil profile.

In the monograph "*Romanian Rivers*" (1971), published by a group of authors from the Institute of Meteorology and Hydrology from Bucharest, under the coordination of C. Diaconu, a balance equation is presented:

$$X + C + Y_1 - Y_2 - Z + U_1 - U_2 + W_1 + W_2 = 0,$$

where: X – atmospheric rainfall; C – steam condensation; Y_1 - surface runoff intake from the surrounding areas; Y_2 - surface runoff outside the area under consideration; Z – global evaporation; U_1 - underground waters intake from the neighbouring areas; U_2 - underground waters drain towards neighbouring areas under the level of their drainage towards the river beds; W_1 - variation of the humidity reserve in the soil (including underground water); W_2 - variation of the humidity reserve at the surface of the area under consideration.

According to the authors, depending on the application conditions and the intended purpose in the usage of the balance equation, some terms can be detailed or, on the contrary, neglected, or included in other terms. There is a mentioning, however, that condensation, due to the practical conditions of determination, and to its reduced values, is taken into consideration, conventionally, together with the rainfall or it can be neglected.

Moreover, on applying the balance equation for hydrographical basins, many terms are neglected: $Y_1 = 0$, in the case of a hydrographical basin for which the line of the watershed can be traced precisely; the terms W_1 and W_2, during a multiannual period are compensated both for large basins and for smaller ones; for large basins, the terms U_1 and U_2, during a multiannual period can be neglected.

3.2.2.2. Methods of evaluation of the periods of pluviometric excess

Considering the fact that the rainfall is one of the most important factors in establishing the water excess, in the following lines, I considered it essential to mention the most important indices and methods, with which climate risks can be analysed, in this case – ***the rainfall***. The indices and methods from this category have the advantage that they can be applied to determine the features of several climate elements and phenomena. These include: *the ANGOT monthly pluviometric index, the standardised rainfall index, the standard deviation, the standardised climate anomalies, the cumulative curve of the standardised rainfall anomaly, the structure of the rainy/ droughty periods.*

3.3. PREVENTION AND CONTROL OF THE WATER EXCESS IN THE SOIL AND ON THE SURFACE

The maintaining and improvement of a fertility degree of the soil in the areas affected by an excess of humidity represents a major concern in all the countries, in order to ensure primarily the food and shelter needs of the constantly growing population, but also to develop economical activities and for the role played by this as a physical support of the elements of the natural and anthropic frame. On the other hand, the strong anthropic pressure on the soil has led to a disorder in the complex balance established between the abiotic and biotic factors , a balance which needs to be re-established. From this point of view, the soil protection activities are based especially on the works of land improvement which take into account the elimination of the water excess on its surface.

3.3.1. The prevention of the water excess

Prevention consists of all the activities meant to avoid or reduce to a minimum the consequences of extreme events, as a result of the cumulative knowledge and of forecasting activities, the later ones representing an ensemble of activities dedicated to the study and determining the causes of these extreme events, to the identification of the risk and to the individualization of the areas exposed to risk. An important role is played by the ***disaster prevention plans***, which are studied by various compartments of several ministries (of waters, of agriculture, of the environment, etc.). Quite often, these plans are assigned to some research units under the above mentioned ministries' authority. *These prevention plans* must include the risk areas, the places of maximum risk, the escape routes, hideaways, control and help centre location, dangerous transport axes, etc.

3.3.2. The control of the water excess

The technical procedures through which excess water is eliminated from the surface of the land or from the soil profile - ensuring thus optimal conditions for the development of the crops and at the same time for the improvement of other phenomena and processes caused by humidity excess - are represented by **the draining methods – drainage.**

The completion of the works of humidity excess control, at the surface of the plot drainage requires conducting specific studies and analyses, including the most relevant ones:

- *Determining the sources of the humidity excess***.**

- *The analysis of the choice solutions of the most advantageous technical-economical options.*
- *The exploitation and the proper maintenance of the planning made through: Hydrological efficacy and economic-ecological efficiency of the works for the disposal of the humidity excess.*

4. FACTORS IN THE DETERMINATION OF THE WATER SURPLUS

While determining the water surplus in the Somes Plain, they analyzed the triggering factors which are directly involved in the formation of the risk phenomenon, as well as the potential factors that amplify the phenomenon through their location and structure.

4.1 THE TRIGGERING FACTORS

In order to assess the causes of the water surplus accumulation one must consider firstly *the triggering elements*, especially those related to climate (precipitations regimen) and, depending largely on these, the hydrological ones (water resources and flow), constituting together the dynamic factor.

4.1.1. The climate and the rainfall regimen

The analysis of the climatic factors, mainly of the rainfall ad temperature ones must be considered globally in the context of the modification of world climates and particularly in the local conditions that are specific to the studied plain unit.

The climatic and rainfall regimen of the Somes Plain are determined by its geographical position in the north-west of the country, more likely to incur advections of humid air and because of the features of the active surface, among which the relief, through exposure, sloping and hypsometry, plays a dominating role. In this work for the climate analysis that was carried out in order to establish the main climatic parameters which influence directly the formation of the water surplus, the ***precipitations*** to be exact. The chosen analysis period was 1979-2004 (26 years) and of all the meteorological and pluviometry stations only 11 share this period, namely Satu Mare, Sacuieni (meteorological stations), Gherta Mare, Pasunea Mare, Turulung, Valea Vinului, Hrip, Berveni, Domanesti, Supuru de Jos and Valea Morii (pluviometry stations) (figure 20).

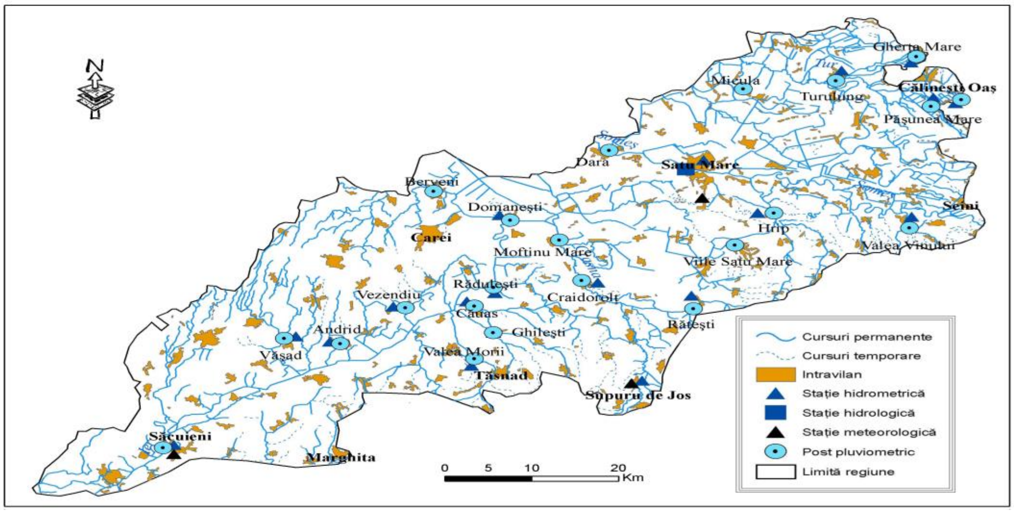


Fig. 20. Locations of hydrological and pluviometry data collection points

Maximum annual precipitation amounts sometimes exceed 800 mm/annum in the eastern part of the Somes Plain, where it links with the higher neighbouring land features. The rich precipitations are due to the fact that the area is frequently influenced by the advections of oceanic air masses, being often crossed by baric depressions and their associated atmospheric fronts from the Northern Atlantic. The maximum monthly amounts recording in the period were 99.9 mm at Sacuieni on 12 September 2001, 88.0 mm at Valea Vinului on 4. October 2003, 77.8 mm at Gerta Mare on 30 September 1992 and 72.1 mm at the Hrip Pluviometry Station on 12 August 1984 (table 10).

Analyzing the dynamics of the annual precipitation amounts at the above mentioned meteorological and pluviometry stations over the common 26 year-period, from 1089 to 2004, one remarks the fact that the rainiest years in the Somes Plain were 1979, 1980, 1998 and 2001 with the persistence of cyclonic activity, with a great number of years with values over 800 mm at most of the pluviometry stations, when the air temperature was high thus amplifying the thermal convection of the air.

Table 10. Maximums of the annual and daily precipitation sum in the Somes Plain.

Nr. crt.	**Meteorological/ pluviometry station**	**Sum per annum (mm/year)**					**Daily annual maximum pp. (mm)**				
		Recording year					**Date and year of recording**				
1	Păşunea Mare	1151.5	1102.5	1034.3	988.8	951.4	70	58.1	57.9	54.3	52.3
		2001	**1998**	**1995**	**1980**	**1999**	**19.10** **1996**	**28.06** **1982**	**30.09** **1992**	**09.06** **1990**	**14.07** **1989**
2	Gherţa Mare	991.9	974.8	956.1	942.9	931.7	77.8	69.2	59.2	56.2	54.4
		1998	**1980**	**2001**	**1979**	**1981**	**30.09** **1992**	**29.06** **1989**	**02.08** **1991**	**19.06** **1998**	**22.07** **1980**
3	Turulung	920.5	879.4	853.1	809.4	801.1	69.8	56.3	48.7	46.3	44.6
		1980	**2001**	**1979**	**1998**	**1995**	**01.08** **1991**	**3.07** **2001**	**23.08** **1988**	**17.05** **1986**	**25.03** **2004**
4	Valea Vinului	1058.0	1009.4	910.1	869.2	853.1	88.0	71.5	56.1	54.8	54.2
		2001	**1998**	**1980**	**1979**	**2004**	**04.10** **2003**	**03.07** **2001**	**01.07** **1998**	**31.07** **1980**	**25.03** **2004**
5	Hrip	876.5	788.5	786.0	767.3	759.5	72.1	66.0	65.9	65.2	62.8
		2001	**1980**	**1984**	**2002**	**1999**	**12.08** **1984**	**04.10** **2003**	**19.11** **1993**	**10.09** **1995**	**17.04** **1998**
6	Satu Mare	808.7	807.5	779.6	687.8	645.7	59.5	57.9	48.5	44.6	44.3
		1980	**1998**	**2002**	**1999**	**1996**	**22.07** **1993**	**13.07** **1989**	**12.05** **2001**	**17.10** **2004**	**19.10** **1996**
7	Berveni	673.5	642.4	588.5	545.5	503.4	68.7	58.0	50.8	46.8	43.1
		2001	**2002**	**2004**	**1999**	**2003**	**04.07** **2001**	**31.07** **2003**	**11.08** **2002**	**10.05** **1997**	**24.05** **1996**
8	Domăneşti	775.7	733.3	704.4	639.1	633.6	69.0	62.1	58.2	54.7	52.3
		1980	**2001**	**1998**	**1979**	**1984**	**24.06** **1989**	**29.06** **2001**	**10.06** **1992**	**30.07** **2003**	**12.09** **1995**
9	Supuru de Jos	841.0	625.7	612.8	606.7	591.5	62.7	62.3	62.1	60.7	58.9
		1980	**1989**	**1991**	**1984**	**1979**	**30.07** **2003**	**28.07** **1991**	**19.06** **1993**	**16.04** **1998**	**23.06** **1996**
10	Valea Morii	838.3	787.1	785.3	727.6	715.8	67.4	57.1	56.7	55.7	55.0
		2001	**1995**	**1980**	**1989**	**1996**	**13.07** **2003**	**30.07** **1980**	**17.05** **1985**	**20.06** **1995**	**12.07** **1981**
11	Săcuieni	776.1	737.2	711.9	689.0	686.3	88.9	54.9	53.1	52.2	51.1
		1980	**2001**	**1998**	**1979**	**2004**	**12.09** **2001**	**28.07** **1998**	**08.08** **1979**	**17.06** **1983**	**13.07** **1981**

4.1.2. Hydrography

Depending on the geological structure and the paleo-geographical conditions dictated by the sedimentation of the Pannonian Basin and the constituting of the volcanic relief, the hydrography and the underground waters present specific features.

4.1.2.1. Organization and morphometrical features of the hydrographic network

In the analysis of the morphometrical parameters we have utilized the observation data from 9 hydrometry stations along complete year sequences (26 years) from 1979 to 2004, which control hydrographic basins whose altitudes range from 251m to 534 m and with areas between 69 square km and 15,600 square km (**table 11**)

Table 11. Hydrometry stations in the Somes Plain

No.	**River**	**Hydrometry station**	**H (m)**	**F (km^2)**
1	Tur	Turulung	366	1 144
2	Turț	Gherța Mare	315	74
3	Talna	Pășunea Mare	402	186
4	Someș	Satu Mare	534	15 600
5	Valea Vinului	Valea Vinului	251	69
6	Crasna	Domănești	261	1 705
7	Crasna	Supuru de Jos	310	1 170
8	Santău/Cehal	Valea Morii	294	169
9	Ier	Săcuieni	287	1 392

4.1.2.1.1 River and lake systems

The river network in the studied region attracted to the maximum sinking areas of the Tisa Plain comprises 107 codified rivers with a total length of 1487.5 km belonging to two great hydrographic basins: **Somes-Tisa** (Tur, Homorod and Crasna) and **Cris** (Ier) ***(fig. 21)***.

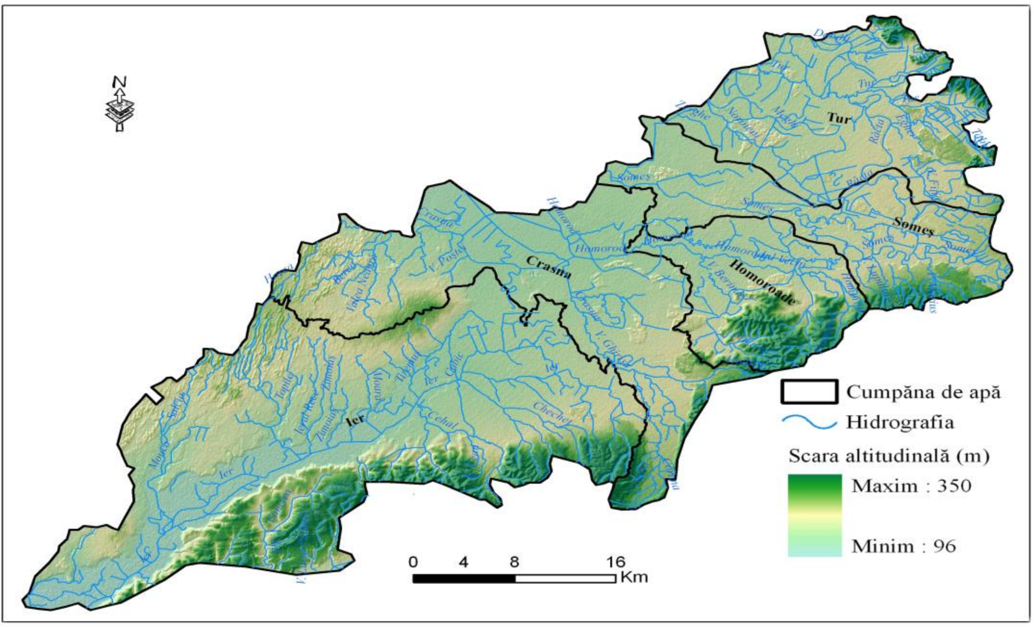


Fig. 21. The sub-hollows and the hydrographic system in the Somes Plain

Still waters from the researched area occupy smaller surfaces because of the hydroworks which have imposed important mutations. At one time the lakes and especially the numerous ponds tied by large marshlands were once a dominant feature of the landscape in this part of the country, the best known being the marshland Ecedea.

After the great floods from 1970's, they constructed Calinesti Oas dam to regulate the water flow, which is situated in the proximity of the Somes Plain preventing floods downstream. Presently among the protected marshlands exist only anthropical lakes, as ponds and stews smaller in size and number. Most of them are on the valleys down from Carei depression to Ier(Andrid- Dindesti lakes, Vășad, Galoșpetru, Șimian), those on the left side are scarce on the valleys Sălacea-Roșiori Plain (Sălacea, Vaida, Ianca, Făncica lakes).

4.1.2.1.2. The exceeding overflow of the rivers

Due to its destructive effects and features(levels, debits, volume, lengths), the exceeding overflow is the most important phase, all the more so for is directly responsible in determining the level of the overflow.

Following the chronological variation of the annual maximum flows over 26 years,1979-2004, in all nine bridges for stream-gauging in Somes Plain, a noticeable fact, in the Turului basin , at Gherța Mare, Pășunea Mare and Turulung, the maximum flows were recorded in 1996, 1997 and 2001, in the Somes hydrographic basin at the Valea Vinului and Satu Mare hydrometric station the maximum flows were recorded in the 1980's and 1981, at the Domanesti and Supuru de Jos hydrometric stations located in the Crasna basin, the maximum flows were recorded in the 1979 and 1989, the Ieru hydrographic basin recorded maximum flows in the 1980's at the Sacuieni station on Ier river and in 1989 on the Santau river at Valea Morii point.(**Table 12**)

Table *12. Annual Maximum Flows*

No.	**River**	**Hydrometric station**	**Q max. (m³/s)**	**H max. (mm)**	**Date (day/mounth /year)**
1.	Turț	Gherța Mare	62.3 59.7 50.6 47.5	484 478 400 440	26.07.1997 09.07.1997 25.03.2004 26.01.1995
2.	Talna	Pășunea Mare	100 96.4 95.5 91.5	410 406 405 400	19.10.1996 19.06.1998 30.10.1998 09.07.1997
3.	Tur	Turulung	223 220 184 177	640 647 622 620	05.03.2001 23.07.1980 21.12.1993 08.11.1980
4.	Valea Vinului	Valea Vinului	126 37.2 28.2 26.5	485 386 363 357	31.07.1980 28.06.1982 26.01.1995 03.07.2001
5.	Someș	Satu Mare	1920 1578 1570	934 852 850	15.03.1981 08.04.2000 07.03.2001

			1558	867	02.01.1979
6.	Crasna	Supuru de Jos	244	638	08.04.1989
			167	564	17.03.1988
			163	656	06.04.2000
			137	560	16.04.1993
7.	Crasna	Domănești	183	622	31.01.1979
			181	665	25.07.1980
			141	718	08.05.1989
			133	758	07.04.2000
8.	Santău	Valea Morii	37.9	340	01.06.1989
			36.2	407	12.04.2000
			21.2	365	04.07.1998
			20.5	358	03.07.1980
9.	Ier	Săcuieni	53.9	445	28.07.1980
			40.9	396	29.01.1979
			40.3	376	11.02.1981
			35.2	357	04.01.1982

4.2 POTENTIAL FACTORS

From all the potential factors involved in determining the water flow, I have noticed those of geological nature, geomorphological, vegetation and the use of the land.

4.2.1. Geological and geomorphic factors

Seen as potential factors in determining the water flow, the geology and geomorphology of the Somes Plain must be viewed and analyzed under the following aspects: the paleogeographical evolution, the geological sublayer , component of rocks, the evolution and shaping of the relief, the hypsometry and particularly the land's incline.

According to geological factors examined , the researched area overlays on a crystalline – mezozoic layer like charphato -pannonic. This layer presents major charphatic and pannonic fractions and look like massive blocks submersed at depths varying between 1500m est and 3000m west(a horst and graben system). In the West Hills region these horsts emerge on the surface as humps formed from hard rock(crystalline charphatic).

On this layer a series of sediments have accumulated varying in size(in the grabens region they are thicker than in the horsts region), clays, composites, gritstones, the thickest sediments are those taking back to miocene pliocene era (over 1000m thick). They incorporate sand layers and volcanic ash (reflecting the consecutive eruptive activity of the near volcanoes).

The altitude of the Somes Plain, including the 18-20m terraces is between 98 and 218m above sea level. Unlike the adjoining Oas and Baia Mare basins , the plain displays medium asperities of 60-70m on a relatively short coverage. The incline's change of the Pannonic sector has led to a great ramification of the Somes. The level curves have a double orientation from SE to NW and form the E to SW. They concord with the main rivers' flow: Someș, Tur, Homorod, Crasna and Ier.

The former morphological data , helps us to distinguish multiple relief subunits with remarkable evolutions. The older subunits are represented by higher terraces (152-

165m) clearly viewed and fragmented. The newer subunits are represented by the Somes (120-145m), Turului (122-140m) Homorodului (115-130 m), Crasnei and Ierului everglades. The lower plains have their surface alluvial soil covered in delluvial and proluvial deposits. The low banks and platforms are formed from delluvial proluvial deposits. The alluvial proluvial sediments have formed larger terraces.

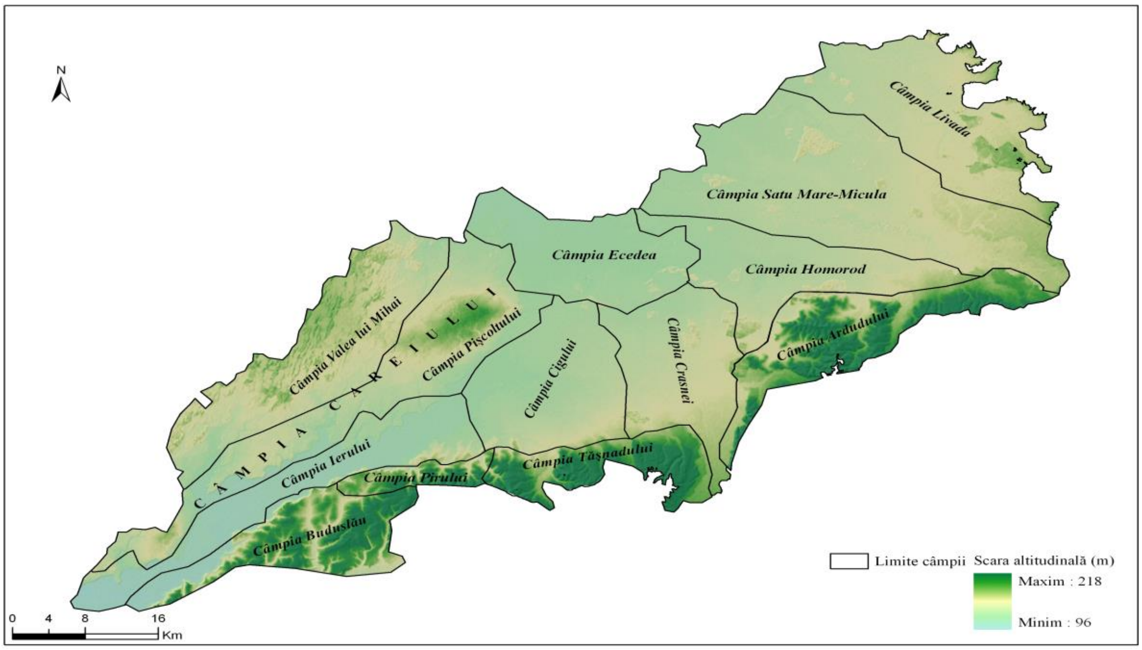


Fig. 26. The high plain and the low plain of Somes(Gr. Posea 1997)

On the Somes Plain there are two forms of relief: the lower plains, which occupy most of the area including: Livada plain, Satu Mare – Micula plain, Ecedea plain, Homorod plain, Crasna plain, Gicului plain and Ierului plain and the high plains: Carei Plain, Ardud plain, Tasnad plain, Pirului plain, and Budulsau plain(fig.26).

The low plains, were once active sedimentation areas, on which changing rivers and winds have deposited thicker layers of alluviations(mud, sand, clay, rock), and thinner layers of aeolian deposits due to their weak incline (0,3-0,4%) have a limited surface drainage, favoring water accumulation and marshlands. From a morphometric analyze resulted a general weak incline of the South Est to North West area, which has defined the changing course of the rivers, the small asperities in the soil(5-6 m between the bottom of the valleys and the maximum peak of the inter river), as well as the low depth of the rivers (0,5-2,5m), whose banks are now easily flooded.

The relief of the inter rivers presents faded positive and negative microforms. The positive microforms are actually the old inter rivers devised by the relict riverbeds spread along the bank, and the negative microforms represented by relict riverbeds known as “streams” or “ponds”.

The high plains are smaller in size and number. At the junction between Silvaniei Hills and the Somes Low Plain, a line of glacis is unveiled of 10 -15km width, on an 560 km2 area, which forms a high plateau on Somes plain. Across its entire 100km length the fragmented relief by the Homorod, Crasna, Ier rivers and its streams, represents various forms either mild as in Crucişor-Ardud-Beltiug and Acâş-Tăşnad-Sălacea, or steep as between Beltiug and Dobra and Sălacea-Diosig.

4.2.2. The edaphic factor

Among all potential factors the edaphic one has a special role, prevailing the illuvial-clayish soil and hydromorphic soil formed in a humid sub atlantic temperate climate.

Somes plain's soils were formed in a continental temperate climate with average temperatures of 9.5C and rainfall of 600 and 800mm, and in a relief with an altitude of 98 - 220m. Consequently in the Somes plain the following soils were formed: alluvial soil, chernozem, eutric cambisol, gleysol, luvisol soil, solonetz, stagnosol and in combinations vertisols and thorn forest soils. The soils of Somes' plain were recorded at 1:100 000 on scale, and described in detail in a paper by the O.J.S.P.A. Satu Mare, based on the paper by Asvadurov H., Boeriu I. (1983), *(fig. 29).*

4.2.3. The vegetation and usage of the land

Over the time, the natural flora has suffered great changes under the anthropic action. In the past forests have occupied large sections forming massive and dominant components. They interchanged with silvosteppe meadows with a rich flowery content. In time, a great proportion of the old oak forests were deforested for agricultural purposes and farming and a large part of the meadows were fallowed , presently just ¼ of the plain's surface is covered by natural flora.

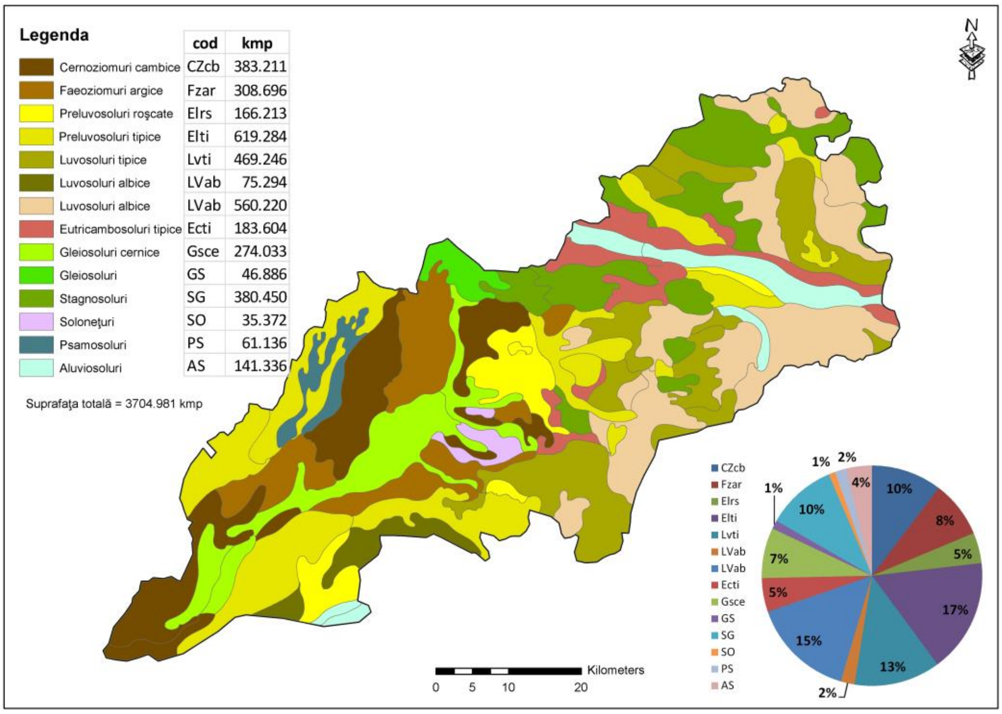


Fig. 29. The distribution of soil types in the Someşului Plain,
(according to H. Asvadurov, 1983, M. Oncu, 2008)

From a bioclimatic point of view, the largest part of the Someşului Plain belongs to the *forest area*, except the Carei Plain - Valea lui Mihai, which belongs to the *forest steppe*. The variety of the elements in the area used to be even more varied due to the associations of the vegetation, the *eutrophic marshlands, everglades, saline lands,* and *sandy areas* being the characteristic ones.

The general characteristic of the natural landscape from the Someșului Plain used to be given by the presence of marshlands with hydrophilic vegetation and that of the extensive oak forests. As consequence of centuries of deforestation, the forests in the Someșului Plain can be found today only as clusters, isolated witnesses of forests of yore, whereas the eutrophic marshland and the everglade vegetation has disappeared almost completely as consequence of the dam building and draining performed during hydro-meliorations. Even the sandy areas have undergone major changes, the dunes from the Valea lui Mihai Plain being settled mostly by acacia and viticulture plantations.

Nowadays, similarly to most plain regions in Romania, in the Someșului Plain the agricultural crops, farming land, represents the main form of ***land usage***. Pasturelands and natural hayfields and grazing lands (which are actually secondary pasturelands) usually cover the less fertile areas and the woods are larger only in the sandy area of the Nir and on the shady slopes of the piedmont plains. *(Kovács Csaba Miklós, 2005).*

As far as the vegetal system as a potential agent in the determination of plain water excess, as witness of the existence of humidity excess in the ground is concerned, a special interest is to be given to ***the everglade vegetation.*** The existing vegetal system is represented by the everglade woods, salt marsh vegetation, sandy land vegetation, leaf-bearing woods, and the forest steppe.

5. THE RESULTS OF THE RESEARCH

5.1. THE HYDRIC RESULTS IN THE SOMEȘULUI PLAIN

In establishing the hydric result of an area, the medium values of the equation for the respective period of time are used, expressed in *mm*, the main components being represented through the constituent elements of the water circuit. Thus, the **positive part of the hydric results** is represented by *precipitations*, whereas the **negative** part is made up of the *evapo-transpiration, leakage and other losses.*

5.1.2. The distribution of the constituent parts of the hydric results

With reference to the constituent parts of the hydric results, they have an inconstant distribution in time and space, conditioned by the geographical features of the studied area. In a plain area with a small offset of the variation of the altitude, obvious differences as far as the territorial distribution of the main components of the results are not noticed at a first glance.

5.1.2.1. The medium amount of precipitation.

The distribution of the medium amount of precipitation (Xo) chiefly determines the spatial variations of the other elements of the hydric results. An analyses of the spatial distribution of precipitations at the level of the main geographical sub-units of the Someşului Plain reveals quite obvious differences (table 12).

Table 14. The distribution of the general average of the multi-annual quantities of precipitations (mm) according to the intervals of altitude from the geographical sub-units of the Someşului Plain

Intervals of altitude (m)	THE LOW PLAIN							
	The low Someşului Plain					*The Ierului Plain*		Total average
	The Livada Plain	The Satu Mare-Micula Plain	The Homorod Plain	The Ecedea Plain	The Crasnei Plain	The Cigului Plain	The Ierului Passage	
98-100	-	-	-	-	-	-	515.0	515.0
101-150	582.5	573.6	569.5	547.5	578.4	561.3	539.0	564.5
General average	**582.5**	**573.5**	**569.5**	**547.5**	**578.4**	**561.3**	**537.5**	**566.4**

Intervals of altitude (m)	THE HIGH PLAIN					
	The Ardudului Plain	The Tăşnadului Plain	The Pirului Plain	The Buduslăului Plain	The Carei-Valea lui Mihai Plain	Total average
98-100	-	-	-	516.0	-	516.0
101-150	602.9	609.2	602.4	578.5	578.0	594.2
151-200	657.8	662.3	652.5	651.4	628.7	650.5
201-250	722.4	728.3	720.8	715.3	-	721.7
General average	**636.3**	**655.3**	**627.3**	**611.2**	**571.3**	**603.6**

Thus, the most reduced quantities of precipitations have been calculated for the Low Plain (566,4 mm), where the lowest values have been recorded in the Ierului Passage (537,5 mm). The highest values within The Low Plain have been recorded in the Câmpia Livada or Turului Plain, where the air masses meet the barrier of the Oaş Mountains, leading to the development of significantly larger quantities of precipitation compared to the rest of the sub-units from the Low Plain, namely 582,5 mm. Somewhat higher values of the general average of the multi-annual precipitations are characteristic to the High Plain (603,6 mm), where the most abundant precipitation can be found in The Tăşnadului Plain (655,3 mm), followed by The Ardudului, Pirului, and Buduslăului Plains, all of which are in direct contact with the nearby hills. ***(table 14)***.

5.1.2.2. The average leakage represents the general indicator of water resources from rivers, offering the measure of the water potential of the rivers from a certain area. Knowledge regarding the values of the average leakage is of utmost importance in all studies that research the possibilities of rational capitalisation of water for different socio-economic purposes. In the analyses of the average leakage, observation data from 9 hydrometric stations has been used ***(img. 34)***, which control hydrographic reservoirs with varying altitudes between 251 and 534 m, and surface between 69 km^2 and 15 600 km^2 ***(table 17)***.

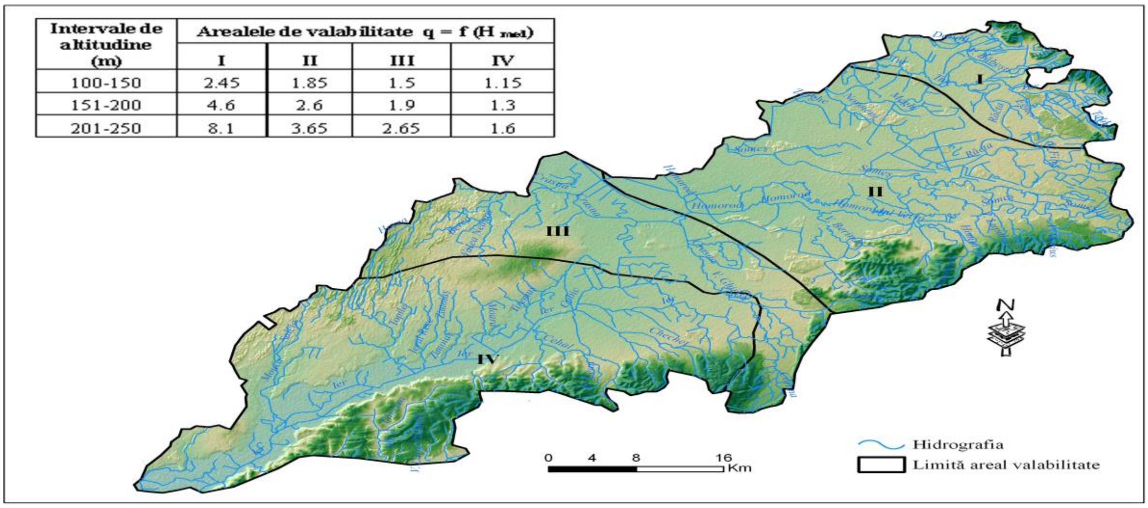
Table 17. Basic data regarding the multi-annual average leakage (1979 – 2004)

River	**Hydrometric station**	**Surface (km²)**	**Average altitude (m)**	**Q (m³/s)**	**q (l/s.km²)**	**V (mil.m³)**	**Y (mm)**
Talna	Păşunea Mare	186	402	2,361	13,891	74,45	437,97
Turţ	Gherţa Mare	74	315	0,471	12,873	14,85	405,8
Tur	Turulung	1 144	366	10,895	14,864	343,58	468,7
Valea Vinului	Valea Vinului	69	251	0,311	4,653	9,80	146,8
Someş	Satu Mare	15 600	534	129,006	8,270	4068,33	260,8
Crasna	Domăneşti	1 705	261	5,920	3,472	186,69	109,5
Crasna	Supuru de Jos	1 170	310	4,164	3,559	131,31	112,2
Ier	Săcuieni	1 392	287	3,186	2,367	100,47	74,6
Santău / Cehal	Valea Morii	169	294	0,193	2,118	6,08	66,9

Since the hydrographic network from the Someşului Plain is hardly native, the main rivers coming from abroad, in order to characterize the water resources from the plain and to compare them with other geographical units nearby, the specific average leakage is used, representing the quantity of water that runs over an area unit (km²) in a second (s). It is obtained by contrasting the flow of the river in a certain point with the area of the respective reservoir. The values thus obtained have been correlated with the morphometric elements of the receiving reservoirs.

The closest correlations have been obtained with the average altitude, which has allowed a territorial generalisation of the values of the average annual leakage ***(img. 35)***. The increase of the leakage together with the rise of the altitude of the landform highlights the different share of the landform steps in producing the average volume of liquid leakage ***(table 19)***. Subsequently, it is to be noted that almost the entire volume of water run in the rivers from the Somesului Plain (79,6%) comes from the interval of altitude between 101 – 150 m ***(table 20)***.

Compared to this average situation differences occur both in the main subdivisions of Somes Plain and sub-units belonging to them. Thus, in the Lower Plain, 99.5% of the annual average is attained on the relief level mentioned, while the amount of water flown on the High Plain on the same range of height is only 59.7% of the annual volume, due primarily to the fact that most of the plain, 2 200 km² of the 3600 km² is between 100-150 m.



Intervale de altitudine (m)	Arealele de valabilitate $q = f(H_{med})$			
	I	II	III	IV
100-150	2.45	1.85	1.5	1.15
151-200	4.6	2.6	1.9	1.3
201-250	8.1	3.65	2.65	1.6

Fig. 35. Areas of relations validity q = f (Hm) for SomesPlain

Table 19. Distribution on altitude intervals of average multianual flow on Somes Plain

Altitude intervals (m)	**Q (m^3/s)**	**q ($l/s.km^2$)**	**V (mil. m^3)**	**Y (mm)**	**% of the amount of water flown**
98-100	0.031	1.90	0.979	59.9	0.4
101-150	7.059	2.18	222.597	68.7	89.1
151-200	0.760	2.08	23.954	65.5	9.6
201-250	0.070	2.36	2.199	74.4	0.9
Total	**7.919**	**4.435**	**249.728**	**68.3**	**100.0**

Table 20. Distribution of average multiannual flow on altitude intervals of the main subdivisions of Somes Plain

Altitude intervals (m)	**Low Plain**				**High Plain**			
	Q (m^3/s)	V ($mil.m^3$)	Y (mm)	% of the amount of water flown	Q (m^3/s)	V ($mil.m^3$)	Y (mm)	% of the amount of water flown
98-100	0.019	0.59	36.3	0.5	-	-	-	-
101-150	3.773	118.97	54.1	99.5	1.226	38.668	37.1	59.7
151-200	-	-	-	-	0.760	23.954	65.5	37.0
201-250	-	-	-	-	0.070	2.199	74.4	3.4
Total	**3.791**	**119.562**	**53.9**	**100.0**	**2.055**	**64.821**	**45.1**	**100.0**

- Temporal variation of annual flow

For a more detailed characterization of the flow from year to year, module coefficients of variation and asymmetry were used. In outlining the areas with the highest and lowest average annual flow, module coefficients of annual average flow modulators were used for nine more representative hydrometric stations of the Somes Plain. Following the chronological changes in average annual flow for the period 1979 - 2004 in all nine hydrometric stations corresponding to the major rivers across Somes Plain, it was noted that the richest flow was in 1980. Other years with massive flow were 1995 and 1998 in Tur river basin, 1998 and 1999in Crasna river basin, 1996 and 1999 in Ier river basin. Maximum average anual flow coefficient module debit value(2,987) was recorded in 1980 in Valea Morii, on the Santău river. Years having the lowest flow in the aforementioned period were 1985 and 1995 in Ierului river Basin, 1990 in Tur, Somes and Crasna rivers Basin, 1992 and 1994 in Somes river Basin, 2003 in Tour and Somes rivers Basin. The minimum average anual flow coefficient module debit value was recorded in 1985, also on Santău River at Valea Morii; 0,001 m^3 / s on Valea Vinului in Valea Vinului; 0,002 m^3 / s; 0,002 m^3 / s on Turţ in Gherţa Mare; 0,097 m^3 / s on Talna in Păşunea Mare, or even 0,000 m^3 / s Valea Vinului in Valea Vinului in 1992 and 1994, and on Turţ in Gherţa Mare in 2003, when the rivers have dried up.

- The global average flow (Yo) is determined also by oro-aero-dynamic conditions of rainfall and the influence of physical-geographical factors. Among these the relief has the most striking influence, causing altitudinal zonality noticed in four areas with different flow gradients.

In the Somes Plain, annual average water volume resulting from overall flow was valued at 249.728 million m³, which corresponds to a medium layer of 68.3 mm. Analysis of the overall flow distribution in the major geographic subunits also highlights the correlation between rainfall, altitude and location of these. Thus in Some Low Plain, in the central part of it, the global average flow layer is between 45 and 60 mm (Satu Mare Plain – Micula, Homorod Plain, Ecedea Plain and CrasnaPlain), higher in the northern part 73.9 mm , where there is a special case noted across the plain, where the Livada Plain or the Tur Plain get in direct contact with the neighboring mountainous formations, with high amounts of precipitation.

In the southern part of the plain, the global average flow layer is lower than the rest of the plain, between 37 and 41 mm (Ier Plain). Average global flow layer in the two subunits of the Low Plains, Somes Low Plain and Ier Plain is 59 mm in the first subunit and and 49.2 mm in the second one (**Table 29 a**).

In the High Plains, the subunits where the global average flow layer is between 38 mm and 50 mm are: Pir Plain, Cara Plain – Mihai Valley and Tăşnad Plain. A slight increase in the flow layer is noted Ardud Plain, 71 mm, and 127.7 mm in Buduslău Plain, where there is recorded the highest altitude across the Somes Plain, 218 m at Sânnicolaul de Munte (**Table 29, b**).

Table 29.a Multianual average global flow distribution (mm) on altitude intervals in the subunits of the Somes Plain – Low Plain

Altitude intervals (m)	LOW PLAIN								
	1. Somes Low Plain					TOTAL	*2. ier Plain*		TOTAL
	Livada Plain	Satu Mare Micula Plain	Homorod Plain	Ecedea Plain	Crasna Plain		Cig Plain	Ier Lane	
98-100	-	-	-	-	-		-	36,3	36,3
101-150	73,9	58,3	58,3	51,5	45,1	59	37,8	41,0	39,3
Average	**73,9**	**58,3**	**58,3**	**51,5**	**45,1**	**59**	**37,8**	**40,7**	**49,2**

Table 29.a Multianual average global flow distribution (mm) on altitude intervals in the subunits of the Somes Plain – High Plain

Altitude intervals (m)	HIGH PLAIN					TOTAL
	Ardud Plain	Tăşnad Plain	Pir Plain	Buduslău Plain	Carei-Valea lui Mihai	
100-150	56,3	44,6	36,3	36,3	34	37,1
151-200	80,2	48,7	41	41	270	65,5
201-250	112	56,5	50,5	50,5	-	74,4
Average	**71**	**48,5**	**38,6**	**127,7**	**38**	**45,1**

5.1.3. Global water balance

For the entire Somes Plain, the balance may be expressed based on the average annual values of the main components in the following way. The intake includes 582.2 mm / year of average rainfall of 50.5 mm which is consumed in the process of forming global average flow and evapotranspiration 531.7 mm by (**Table 31**).

Table 31. Plain water balance structure of the Somes river subunits

Subunit	**Water balance elements (mm)**					
	Xo	**Yo**	**So**	**Zo**	**Uo**	**Wo**
Livada Plain	582,5	73,9	40	508,6	33,9	542,5
Satu Mare-Micula Plain	573,5	58,3	33	515,2	25,3	540,5
Homorod Plain	569,5	58,3	29	511,2	29,3	540,5
Ecedea Plain	547,5	51,5	26	496,0	25,5	521,5
Crasna Plain	578,4	45,1	22	533,3	23,1	556,4
Cig Plain	537,5	37,8	17	499,7	20,8	520,5
Ier Lane	561,3	40,7	21	520,6	19,7	540,3
Ardud Plain	636,3	71,0	59	565,3	12,0	577,3
Tăşnad Plain	655,3	48,5	30	606,8	18,5	625,3
Pir Plain	627,3	38,6	25	588,7	13,6	602,3
Buduslau Plain	611,2	127,7	106	483,5	21,7	505,2
Carei-Valea lui Mihai Plain	571,3	38,0	20	533,3	18,0	547,3
Someş Plain	582,2	50,5	36	531,7	14,5	546,2

5.2. RISKS DETERMINED BY WATER EXCESS IN SOMEŞ PLAIN

The risks determined by water excess in Someş Plain, which have direct and indirect effects, are conected with potentially high catastrophic events, having direct impact on society. These risks are the main subject of this thesis. They are: **floods, soil water excess**, **sloughing** and **groundwater pollution**.

5.2.1. Floods

„***Flood***” means the temporary covering of a land surface with a stagnant or moving water layer, as a result of a sudden but short increase of river’s levels or of another water masses.

5.2.2. High waters

High waters represent those phases where daily, decadal or even monthly discharges, are at high values, above the average annual flow value. In the main basins from Someş Plain, the average duration of spring high water is maintained between 23-27 days in the Tur Basin, 22 - 26 days at the Someş Basin, 21 - 25 days Crasna – Homoroade Basin and 26 -30 days in Ier Basin. It can be observed a slight decrease from north to south for the first four basins, simultaneously with higher rainfalls in the northern plain part. A higher average high waters values can be met in Ier Basin due to low land slope of about 0.05% between Hotoan and Diosig, and also due to entire area’s lowest altitude level from the Someş Plain: 98-140 m. The drained layer of spring high waters fluctuates between 40 and 60 mm. The duration of high waters in the spring of 2000 has reached 31 days in the Tur Basin (Fig. 39), 39 days in Someş Basin, all in the same period in 1977.The threshold reached in Crasna - Homoroade Basin was 30 days, and the duration of spring high waters in Ier Basin was 40 days in April-June, 1978.

Fig. 39. Tur River at Turulung, May 2000

5.2.3. Floods

The analysis of periods with recorded phenomena like flooding on monitored water courses from Someş Plain was made taking into account the peak discharge value, admitting two characteristic types: "the so-called first two floods of the year", respectively the major floods with higher or equal peak discharge than the maximum multiannual average discharge, with a practical example being the flood of May 1970 at Satu Mare on the Someş River.

The data about flood events appearing periods were collected from 9 hydrometric stations across the Someş Plain, four in the main hydrographical basins (Tur, Someş, Crasna and Ier), with a good representation in the territory. To have a common calculation period, allowing comparison of the obtained results, it was chosen an uniform interval for all stations of 26 years (1979-2004).

In terms of seasonal floods frequency, it can be observed several cases (***Table 35***), with a appearance maximum for spring floods (36 – 46 %) in the Someş and Crasna basins registered at Satu Mare, Domăneşti and Supuru de Jos stations, respectively a winter maximum in Tur Basin (40 – 52 %) at Păşunea Mare, Gherţa Mare and Turulung stations. Monthly frequency presents a maximum in June on Crasna River at Domăneşti (17.3 % of the total number of selected floods), in April at Satu Mare on the Someş River (23.1 %); at the other seven stations, maximum floods frequency occurs in January and February (***Table 36***).

Table 35. Seasonal frequency of floods at hydrometric stations from Someş Plain

River	**Station**	**Hmed (m)**	**F (km^2)**	**Season**			
				W	**Sp**	**S**	**A**
Talna	Păşunea Mare	402	170	42.2	30.7	19.3	7.8
Turţ	Gherţa Mare	315	36,6	42.4	19.1	24.9	13.4
Tur	Turulung	366	733	51.9	26.9	11.5	9.6
Someş	Satu Mare	534	15600	28.9	46.2	15.4	9.6
Valea Vinului	Valea Vinului	251	66,8	38.4	38.5	19.2	3.8
Crasna	Supuru de Jos	310	1170	32.6	36.6	19.3	11.5
Crasna	Domăneşti	261	1705	32.7	38.5	21.1	7.6
Ier	Săcuieni	287	1346	46	40	10	4
Santău/Cehal	Valea Morii	294	91	44.3	32.7	19.2	3.8

Table 36. Monthly frequency of floods between 1979 - 2004 (in %, from total)

River	**Station**	**Month**											
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
Talna	Păşunea Mare	11.5	19.2	11.5	9.6	9.6	9.6	7.8	1.9	-	5.9	1.9	11.5
Turţ	Gherţa Mare	13.5	15.4	11.5	3.8	3.8	11.5	11.5	1.9	1.9	11.5	-	13.5
Tur	Turulung	21.1	17.3	11.5	9.6	5.8	3.8	7.7	-	-	5.8	3.8	13.5
Someş	Satu Mare	13.5	7.7	15.4	23.1	7.7	7.7	5.8	1.9	-	5.8	3.8	7.7
Valea Vinului	Valea Vinului	21.1	9.6	17.3	13.5	7.7	9.6	9.6	-	-	3.8	-	7.7
Crasna	Supuru de Jos	11.5	17.3	15.4	13.5	7.7	13.5	5.8	-	1.9	3.8	5.8	3.8
Crasna	Domăneşti	15.4	13.5	11.5	13.5	13.5	17.3	3.8	-	1.9	3.8	1.9	3.8
Ier	Săcuieni	20.0	20.0	18.0	10.0	12.0	6.0	4.0	-	2.0	2.0	-	6.0
Santău/Cehal	Valea Morii	27	11.5	9.6	13.5	9.6	17.3	1.9	-	-	-	3.8	3.8

In flood analysis at stations from the study area we used the constant model for flood parameter estimation. In this regard, we processed the raw data of the two largest floods in year at four hydrometric stations, which had a consistent data base (Someş – Satu Mare, Tur – Turulung, Gherţa Mare – Turţ, Păşunea Mare - Talna). This summary presents only data from Satu Mare hydrometric station.

The data were integrated into CAVIS program - first two floods recorded at the hydrometric stations set above, to give a very consistent specific data fund.

At Satu Mare hydrometric station on the Someş River, were used extensive data for a period of 26 years (1979-2004), taking into account 52 separate floods. Processing these values revealed the following statistical data (**Table 38**).

Table 38. Statistical data about floods at Satu Mare hydrometric station (1979-2004)

Values	**Qmax m^3**	**Wc mil. m^3**	**Wd mil. m^3**	**Wt mil. m^3**	**Hs mm**	**Gamma**	**Ti (h)**	**Td (h)**	**Tt (h)**
Max. Val.	1920	1012.717	682.644	1419.929	91.021	0.842	448	516	964
Min. Val.	289	25.658	50.77	87.22	5.591	0.267	30	33	63
Aver. Val.	851	201.167	244.806	445.973	28.588	0.474	126	199.7	325.6

Special attention was given to starting and closing floods time values, examining in this regard the most sensitive occurrence periods of such phenomena. The starting of the spring season (March-April) is marked by an increased incidence of floods, with the associated maximum in the second decade of each mentioned month. The most vulnerable time of year, which could be affected by the flood phenomena, is between March 10 to 12, when over the analyzed period were found eight separate cases. High vulnerability periods (seven cases) were reported for two days periods: April 10 to 14, while six cases were identified for the intervals: March 8 to 9, March 13 to 20, 7, 9, 10-13 15, and April 19 to 26. The less sensitive periods, without the occurrence of flood phenomena were reported in the intervals: January 16 to 23, February 19 to 20, July 1 to 3, July 19 to 21, August 7 to 28, September 18 to 30, October 1 to 16, November 14-16, November 27 to 30, and respectively December 1 to 14 (**Fig. 46**).

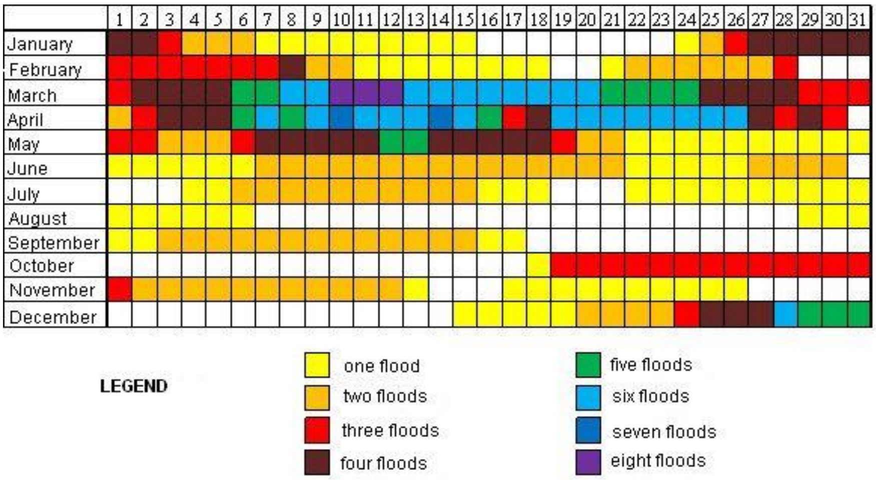


Fig. 46. Incidence of flood phenomena at Satu Mare hydrometric station (1979-2004)

In analyzing the characteristic elements of the flood waves, we took into account data recorded at the hydrometric stations in the analyzed area, respectively parameter values associated with the first two floods from each year in the studied period. (**Table 45 and 46**).

Table 45. Data about first flood's parameters at hydrometric stations

Hydrometric station	**River**	**Year**	**Month**	**Volume (mil. mc.)**			**Duration – Time (hours)**			**Basic discharge (mc/s)**	**Maximum specific discharge (l/s*kmp)**	**Water layer (mm)**	**γ**
				total	**basic**	**flown**	**total**	**incr.**	**decr.**				
Turulung	Tur	1970	May	87,826	21,799	66,027	144	20	124	42,05	708	90,1	0,33
Păşunea Mare	Talna	1998	Oct.-Nov.	10,167	1,683	8,484	82	25	57	5,7	1150	49,9	0,18
Gherţa Mare	Turţ	1997	July	1,523	0,101	1,423	38	5	33	0,735	1631,1	38,9	0,19
Satu Mare	Someş	1970	May	1107,1	405,75	701,37	173	52	121	651,5	214,2	45	0,53
Domăneşti	Crasna	1970	May	109,01	25,177	83,836	428	66	362	16,34	161,9	49,2	0,26
Valea Vinului	Valea Vinului	1980	Jul.-Aug.	4,018	0,297	3,721	66	24	42	1,26	1886,2	55,7	0,14
Săcuieni	Ier	1980	Jul.-Aug..	74,33	7,802	66,528	672	138	534	3,225	40	49,4	0,57

Table 46. Data about second flood's parameters at hydrometric stations

Hydrometric station	**River**	**Year**	**Month**	**Volume (mil. mc.)**			**Duration – Time (hours)**			**Basic discharge (mc/s)**	**Maximum specific discharge (l/s*kmp)**	**Water layer (mm)**	**γ**
Turulung	Tur	1970	June	30,703	4,691	26,012	178	86	92	7,32	126,9	35,5	0,52
Păşunea Mare	Talna	1996	Oct.	13,526	1,063	12,463	144	25	119	2,05	588,2	73,3	0,26
Gherţa Mare	Turţ	1997	July	2,497	0,167	2,331	144	55	89	0,322	1702,2	63,7	0,08
Satu Mare	Someş	2000	March	525,69	186,28	339,41	168	111	57	308	91,9	21,8	0,61
Domăneşti	Crasna	2000	April	44,201	12,208	31,993	216	54	162	15,7	78	18,8	0,43
Supuru de Jos	Crasna	2000	April	22,46	5,821	16,819	84	21	63	19,25	161,5	14,4	0,4
Săcuieni	Ier	1980	May	12,385	3,751	8,634	226	76	150	4,61	19,4	6,4	0,58

The exceeding incidence of defense levels for floods developed in the study area, for which there were enough data for a thorough assessment, led to the delineation of the time intervals which defense levels were exceeded during flood events (time in hours), when the critical thresholds were covered by the water level.

5.2.4. Natural flood risk map

Based on the determined values during floods along the studied period it can be obtained a flood risk map with different probabilities of exceeding. The most common in this sense refers to the value of 1% - the flow value which occurrence probability is once every 100 years. Thus, we conducted a thematic cartographic representation, comprising exposed areas, while completed with linear protection structures exemplified by longitudinal dikes (Fig. 54).

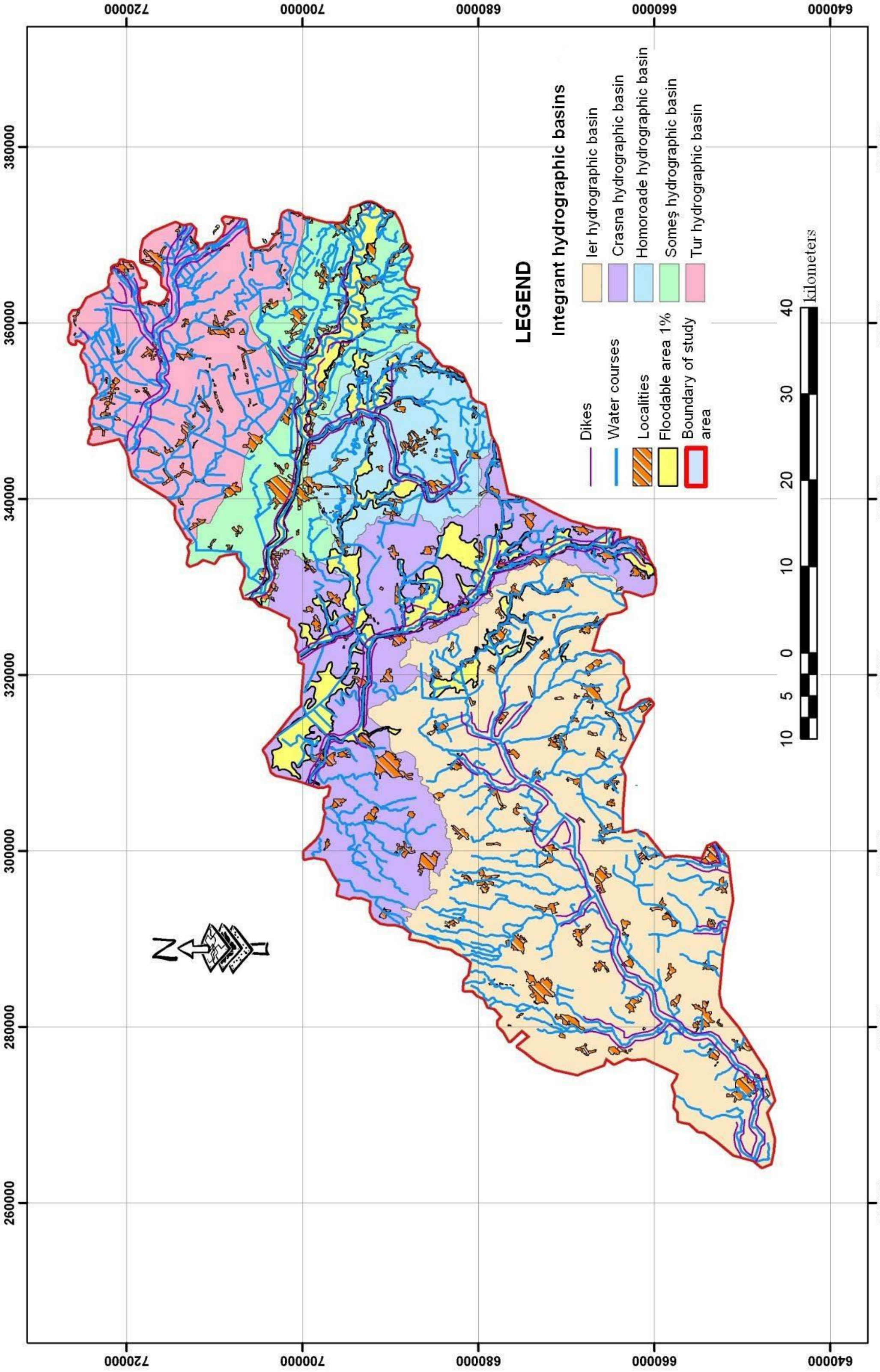


Fig. 54. Map of natural flood risk areas associated with 1% exceeding flow probability.

5.2.6. Soil water excess

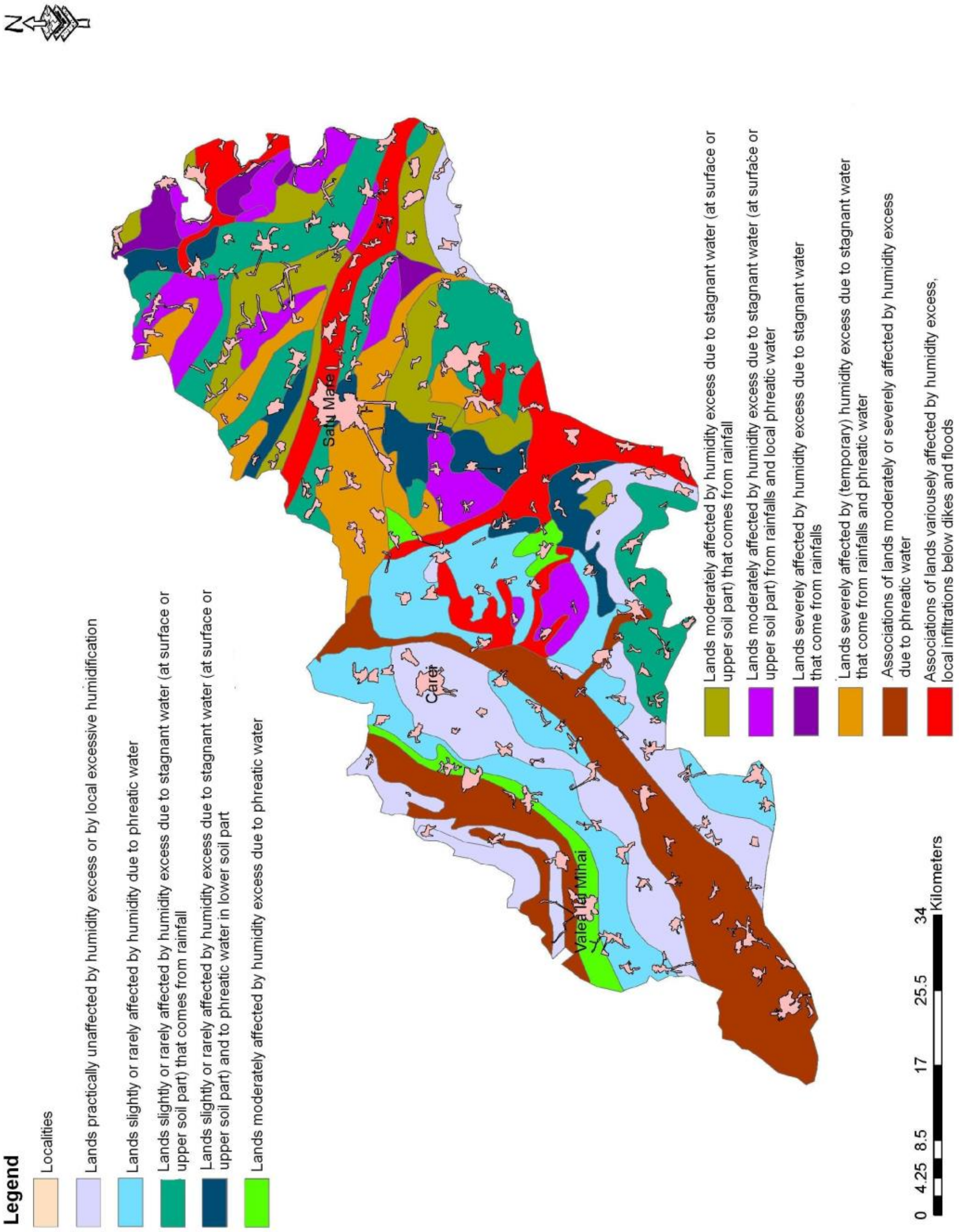
The excess water in the soil is the result of single or simultaneous action of potential and trigger factors, whose manifestation was presented in chapter four. The presence of humidity excess in a certain area causes damage whose size depends on the nature and duration of excess, and also on land use. To these damages may be added those from the deterioration of access roads, farm buildings infrastructure and other territorial planning.

In the study area, water stagnation processes are manifested mainly in the springtime, starting with snow melting, and often extended on some surfaces even till May – June. Demarcation of land with different humidity excess intensities is presented in tabular form, presenting their share in absolute and percentage values (**Table 52**).

Table 52. Lands' typology determined humidity's excess intensity (Asvadurov, 1983)

No. Crt.	**Lands' typology**	**Surface (ha)**	**Percentage (%)**
1	Lands practically unaffected by humidity excess or by local excessive humidification	42100	13,2
2	Lands with no excessive humidification or of short, but frequent duration	7395	2,3
3	Lands slightly or rarely affected by humidity excess due to phreatic water	16859	5,3
4	Lands slightly or rarely affected by humidity excess due to stagnant water (at surface or upper soil part) that comes from rainfall	82780	25,9
5	Lands slightly or rarely affected by humidity excess due to stagnant water (at surface or upper soil part) and to phreatic water (in lower soil part)	13000	4,1
6	Lands moderately affected by humidity excess due to phreatic water	19100	6,0
7	Lands moderately affected by humidity excess due to stagnant water (at surface or upper soil part) that comes from rainfall	25123	7,9
8	Lands moderately affected by humidity excess due to stagnant water (at surface or upper soil part) that comes from rainfall and local phreatic water	28031	8,8
9	Lands severely affected by humidity excess due to stagnant water	8066	2,5
10	Lands severely affected by (temporary) humidity excess due to stagnant water that comes from rainfalls and phreatic water	38441	12
11	Associations of lands moderately or severely affected by humidity excess due to phreatic water	22109	6,9
12	Associations of lands variousely affected by humidity excess, local infiltrations below dikes and floods	16255	5,1
	Total agricultural surface	**319259**	**100**

Thus, it can be seen that the areas of lands affected by excess humidity due to rainfall and phreatic water represent about 20% of the total area of the Someş Plain (types 9 - 10 - 11 from the table above). A map of their distribution in Someş Plain is shown in **Figure 57**.


N
Legend
Localities
Lands practically unaffected by humidity excess or by local excessive humidification
Lands slightly or rarely affected by humidity due to phreatic water
Lands slightly or rarely affected by humidity excess due to stagnant water (at surface or upper soil part) that comes from rainfall
Lands slightly or rarely affected by humidity excess due to stagnant water (at surface or upper soil part) and to phreatic water in lower soil part
Lands moderately affected by humidity excess due to phreatic water
Lands moderately affected by humidity excess due to stagnant water (at surface or upper soil part) that comes from rainfall
Lands moderately affected by humidity excess due to stagnant water (at surface or upper soil part) from rainfalls and local phreatic water
Lands severely affected by humidity excess due to stagnant water that come from rainfalls
Lands severely affected by (temporary) humidity excess due to stagnant water that come from rainfalls and phreatic water
Associations of lands moderately or severely affected by humidity excess due to phreatic water
Associations of lands variousely affected by humidity excess, local infiltrations below dikes and floods
Satu Mare
Carei
Valea lui Mihai
0
4.25
8.5
17
25.5
34
Kilometers

5.2.6.1. Sloughings

The swamp is the phenomenon of soil water saturation, resulting in a surplus of water that soaks or puddles the surface.

The most relevant example concerning the relationship between sloughing - water excess - agricultural operation is the Ecedea swamp, that occupies the plain with the same name, a subunit of the Someş Plain.

The Ecedea Swamp is a complex located near the Carei town, developing also on Hungarian land. Previously to the rehabilitation and embankment works carried out in this area, the swamp was formed in a water discharge space, which outlined here a high flora and fauna diversity. Between 1895 - 1898 there were made extensive rehabilitation works, which strongly amended the original ecosystem. Thus many ponds, marshes, sand banks, reeds, groves, characteristic plant associations, nesting places disappeared. Occupying an area of 450 km^2 (a third is on Romanian territory and two thirds in Hungary), Ecedea swamp was one of the largest wetlands in Europe until the nineteenth century when it was drained (**Fig. 58**). These over a hundred years since the drainage proved that the work did not bring the expected benefits, and at the beginning of the XXI century was born the idea of flooding some territories and partial reconstruction of the swamp.

The swamp's history is defined by successive flooding of rivers represented Nyír, Somes, Crasna, Eriu, Csaronda and Tisa. Over time, silt deposits ensured the lands fertility, favorable for the development of various plant species. Local morphology was defined by islands and even permanent lakes (Tyukod Lake, Ecedea Lake, Ököri Lake). Drainage works had as goal the conversion of the swamp into cropland, limiting the effects of flooding by removing excess water. At the end of the nineteenth century, it was established *The Association for Ecedea Swamp Draining and Floods and Water Infiltrations Regularization on the Left Bank of Someş River* (*J. Lukacs, 2014*). Currently, the swamp is subject to rehabilitation projects, developed by APM Satu Mare and Satu Mare County Council which aime is development of the area in terms of tourism and economic purpose (creation of new jobs in the area: aquaculture tourism, traditional crafts).

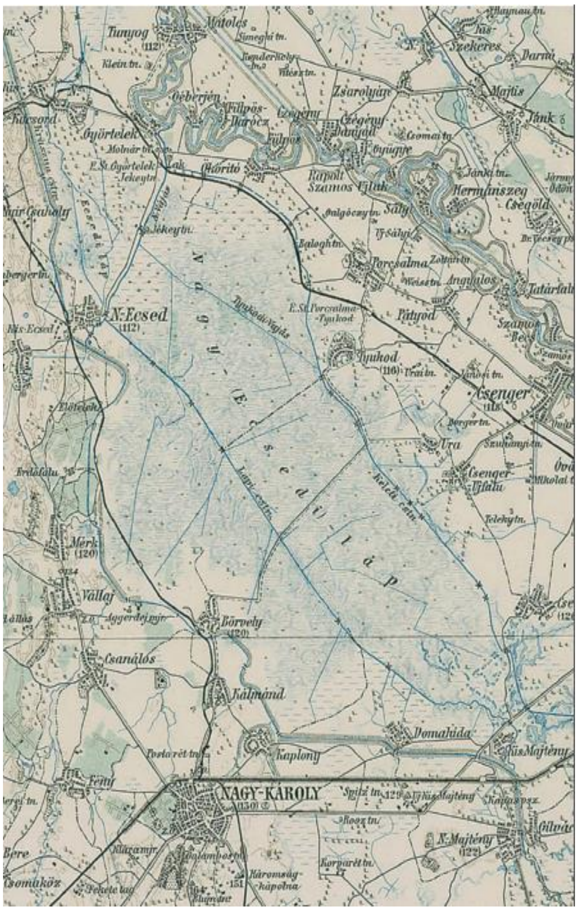


Fig. 58. Swamp at the end of XIXth century
(J., Lukacs 2014)

5.2.7. Floods damages, Chronological and land analysis

The water phenomena that manifests itself through transit of large water volumes on the river banks generated losses expressed by communication infrastructure damaging (road and rail ways), occupying agricultural land with a consistent stagnant water volume for a longer period of time, the damaging of habitat infrastructure (houses, public and social establishments). The indirect damages are expressed by discontinuities in the normal conduct of various activities (population supplying, goods and people transport). The assessment of damages and effects of damages associated with floods were analyzed sequentially, chronologically, depending on data availability and types of damages made accessible. Damage analysis was done for the interval 1996 - 2008. In the summary are presented for the year 1998.

By 1998, the most important hydrological surplus event that caused property damage was carried out between June 15 – July 22, when there have been floods, caused by torrential rain, thunderstorms associated with hail, and river flooding. Table 54 presents an assessment of damages, taking into account the affected objectives.

Table 54 Damages appeared during flood events in the period 15.06 – 22.07. 1998

No. crt.	**Affected locality**	**Water course**	**Damages**
Someş Basin			
1.	Doba	Someş	- 1350 ha arable land
2.	Odoreu	Someş	- 10,5 ha
3.	Culciu	v. Lipău	- 545 ha arable land; 3 bridges and footbridges; 2 km electrical networks
4.	Apa	Someş	- 122 ha arable land in dike-bank area; 372 ha arable land - 5 buildings
5.	Pomi	Someş	- 443 ha arable land; 1,2 km roads; 2 bridges
6.	Crucişor	Someş	- 280 ha arable land
7.	Viile Satu Mare	Someş	- 180 affected houses; 1460 ha land; 170 ha orchards; 80 ha vineyard; 90 ha meadows; 1,5 km country roads
8.	Homoroade	Someş	- 670 ha arable land; 233 houses; 1,1 km country roads
9.	Valea Vinului	Someş	- 300 ha arable land
Tur Basin			
10.	Gherţa Mică	V. Bisericii	- 712 ha arable land; 15 km roads
11.	Oraşu Nou	Tur	- 24 footbridges; 16 km country roads; 67 ha arable land
Crasna Basin			
12.	Berveni	Crasna	140 ml protection dikes; 479 ha arable land; 140 ha meadows
13.	Căpleni	Crasna	520 ml protection dikes;
14.	Moftin	Crasna	500 ml protection dikes; 5000 ha arable land; 400 ha meadows; 21 houses and additions
15.	Terebeşti	Crasna	2670 ha arable land; 1 ha vineyards.
16.	Craidorolţ	Crasna	1195 ml protection dikes; 1738 ha arable land; 125 ha meadows; 1 house
17.	Beltiug	V. Maria, Crasna	- 300 ml protection dikes; - 90 ml erosion dike base
18.	Acâş	Crasn	- 470 ml protection dikes;
19.	Supur	Crasna	- 400 ml protection dikes; 1575 ml bank erosion; 0,4 km country roads; 1760 ha arable land; 53 flooded households.
Ier Basin			
20.	Santău	Ier	- 960 ha arable land; 4 flooded houses; 0,2 km country roads
21.	Cehal	Ier	- 36 flooded households; 470 ha arable lands; 0,1 km roads

6. PREVENTING AND CONTROLLING INDUCED EFFECTS OF HYDRIC STATIONARY PHENOMENA AND PROCESSES IN SOMEŞ PLAIN

Flood risk management involves a series of measures and activities that can be classified as: preventive and preparedness measures, operative intervention measures during the flood, and restoration and rehabilitation measures after phenomena advancement. Preventing and combating the effects of induced phenomena and stationary hydric processes effects involve considering some structural and nonstructural measures.

6.1. STRUCTURAL MEASURES

6.1.1. Irrigation and drainage works

Efforts to prevent and combat the induced effects of stationary hydric phenomena and processes relates primarily to the elimination of water excess from the soil through specific land works. These works include: regulation of water, damming of rivers and surface and underground drainage. The purpose of these actions is to collect, transport and dispose the water excess into the emissaries (*Constantin, Elena 2011*).

6.1.1. The history of irrigation and drainage works

The land's reduced slope, the water intake brought by alohtone water courses, favored the development of puddling and stagnant water phenomena on large areas from the Someş Plain. Human intervention on the river system were conducted both in qualitative and especially quantitative aspects, with strong changes both at underground (position of hydrostatic level) and ground water level (reducing the areas with stagnant water, correcting the flow path, creating of an extensive network of drainage channels).

The Someş Plain groundwater levels from before interventions were very close to the surface, sometimes on the surface. After digging drainage channels, the hydrostatic level of Someş Plain fell to 2-3 m depth, being conditioned by water levels from channels and by the configuration of relief. As a consequence of Someş Plain hydrostatic level decrease, there were some changes in soil structure and texture. This entailed changes in the vegetation and the wildlife of the area.

One of the most interesting aspects refer to flow patterns correcting of rivers in this region. Thus, the Tur and Crasna rivers, before the works, were flowing into the Someş River. After completing these interventions, those rivers have become direct tributaries of the Tisza river, in Hungary. Another good example in terms of changing the appearance of the river system, is the execution of Homorod Belt Channel, of 30 km long. Through this channel, the waters of Homorod, Sărata and Bălcăuţi rivers were diverted from their original route (to Ecedea Swamp) and led directly into Someş River near Satu Mare.

After 1970, hydro technical works have taken a new momentum, when it was built the dam of Călineşti – Oaş Reservoir for Tur River flow regulation the flow; was widened the gap between Someş River dikes, was conducted the complete channeling of Ier River and was practically drained the entire Someş Lower Plain. The main drainage measures were the development of opened channel networks of various sizes, of hydraulic nodes and pumping stations.

Following the works carried out in early 1982, the Someş Plain's territory protected from floods and stagnant waters is divided into three hydro technical complexes comprising sub-drainage systems:

1. ***The Someş – Tur Hydro Technical Complex (with eight embankment – draining systems)***
    a. The Someş River embankment system – right bank
    b. The Tur River embankment system
    c. The Someş River draining system – right bank
    d. The Culciul Mic – Livada draining system
    e. The Sár – Egher draining system
    f. The Tur River draining system – left bank
    g. The Tur River draining system – right bank
    h. The Tarna Mare, Tarna Mică Holţ-Batarci draining system
2. ***The Someş – Crasna Hydro Technical Complex (with six embankment – draining systems)***
    a. The Someş River embankment system – left bank
    b. The Crasna River embankment system
    c. The Keleti draining system
    d. The Lapi draining system
    e. The Homorod draining system – right bank
    f. The Crasna draining system – left bank
3. ***The Ier Hydro Technical Complex (with two embankment – draining systems)***
    a. The lower Ier River draining system
    b. The Peneszlek draining system

Detailed description of these systems with their component elements is shown in this chapter, in the extended work. For summary, there was included only a summary of the Someş – Tur hydro technical complex.

6.1.2. Someş – Tur hydro technical complex

Someş – Tur hydro technical complex overlaps the Someş Plain and is located on the lower Someş River on its right bank. The territorial delimitation is made in south and southwest by Someş River, in east and north by Oaş Hills and in west by the border with Hungary. The total occupied area is about 61,000 ha, of which 47,000 ha are improved through dikes and water draining works from the upper area.

The lands located within the Someş – Tur complex were subject to periodic flooding, most notably those from 1784, 1834, 1855, 1870, 1888, 1898 (Budescu, 1962). In 1835 it was developed the project "Regularisation Somes and Crasna rivers" that involves river flow pattern correcting through bank corrections. The action continued through the action of "The Association for Someş River regularization" (founded in 1855). Since 1871, Satu Mare Water Service made a series of projects to regulate water excess issues: resizing and extension of Someş right dike, collecting water from the high area through a channel belt constructed to limit the floodplain, and creating a network of interior drainage channels. In 1914, "The Someş-Tisa Association" managed the completion of the Someş River right dike and began regulating Tur River by making a bypass channel. After 1920, The Someş – Tisa Hydraulic Union solved the Tur regularization by constructing parallel dikes following the existent ones. Was also realized the Culciul Mic – Livada Channel, to take the waters from high areas and to lead them to Someş River. After 1950 were carried out damming works on Tur River represented by: embankments for existing dikes canting, regulation of the riverbed and of Turţ – Hodoş Channel, and local facilities. The right dike of Someş River was conducted during 1884-1907 and 1914-1915, initially at a higher elevation (c - 0.5 m) compared to the value achieved by the flood of 1888. Subsequently, it was found that this value is undersized and went over to a cant compared with achieved levels at the flood of 1919. The cant works were carried during 1953-1954.

Meanders cutting were conducted between Dara and Ardusat over a length of 18.2 km, the largest adjustments being made at Seini and Roşiori-Someşeni. Development of the channels system on the right sector of Someş River around Satu Mare area is shown in **Figure 63**.

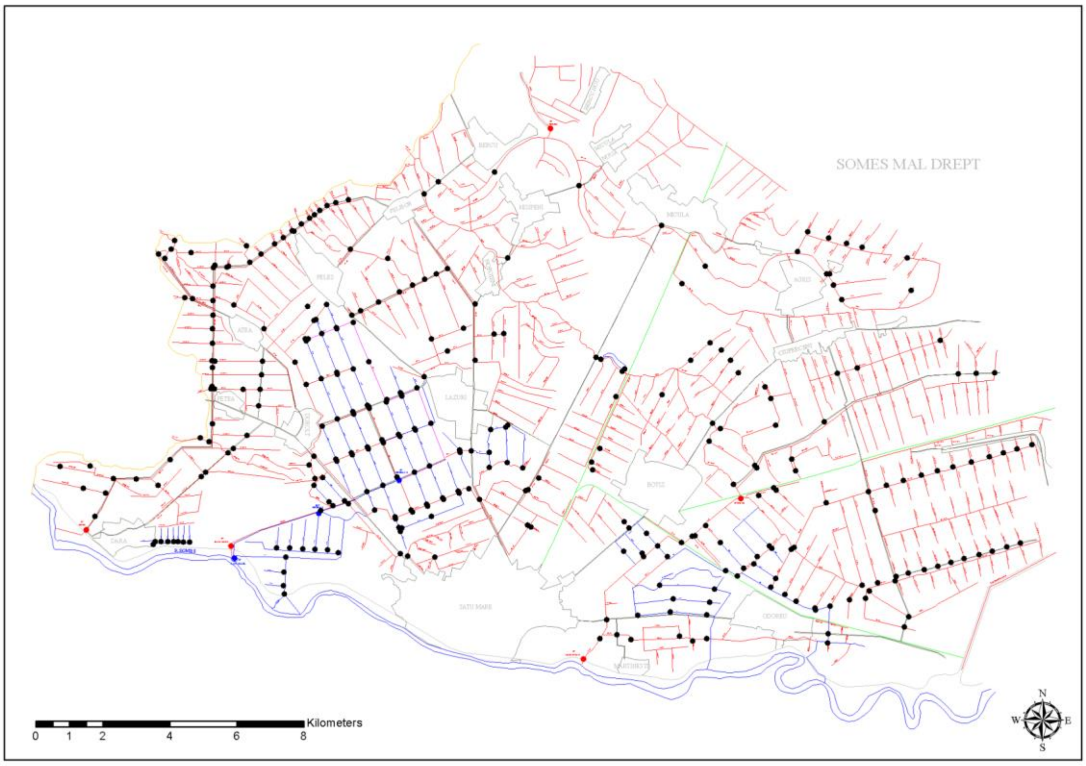


Fig. 63. Sketch of secondary, main and collector channels located on the right bank of Someş River near Satu Mare (after ANIF, 2013)

6.1.2. Hydrotechnical works

Drainage works, made through specified hydro technical channel systems are complemented by a series of hydro-technical facilities, many of which have as main function the mitigating of flood waves and flow regulation.

The most relevant hydro technical works are represented by:

- Călineşti-Oaş Accumulation – which is described in this document,
- Crucişor Accumulation
- Moftin Accumulation
- Hodoş Accumulation
- Dada Accumulation
- Tămăşeni Accumulation
- Mujdeni Accumulation

- Prilog Accumulation

Călineşti-Oaş Accumulation is the largest hydro technical objective associated with reservoirs in the adjacent Someş Plain area (***Fig. 71***). The study area limit overlaps the reservoir's closing. Meandered nature of the Tur and Talna rivers, together with frequent over bank water flow during periods of excess rainfall, were the premises for Călineşti Dam construction. The works began in the 1970s, the accumulation being opened in 1972.

The dam itself is made of clay ground and has a maximum height of 9.5 m. Upstream slope has a gradient of 1: 3.5 and is protected by a simple concrete revetment of 15 m thick (II importance) sitting on a bed of ballast. Downstream slope is enclosed in grass with a width of 1.50 m. The dam's crown is situated at 148.50 mdM and has a width of 4.40 m, being not trafficable. The maximum width of the base is 70.00 m, and the slope of the upstream face is 1: 3.5, and the downstream is 1: 3.

Călineşti – Oaş Accumulation is sized to ensure a probability of 1% and be verified for 0.1%. The dams on the Tur River upstream the Călineşti Accumulation and those from Tur tributaries are designed to ensure a probability of 5% and be verified for 1%. In the 1978-1981 period there were arranged also the Tarna Mare, Tarna Mică, Bătarci and Dobruşa streams.

The storage lake behind the dam has a maximum length of 4.7 km and an average width of 1.2 km, covering an area of 382 ha. The controlled lake area is 370 km^2. In time, due to specific factors, the lake went through some intense silting processes. These are determined by the basin's geomorphological conditions, by substrate's geology and soil, by the protective green cover, by the development of the hydrographic network and by the human activity that occurs in the course of natural processes. Successive development of silting processes were done while topo-bathymetric lifting, showing accumulation areas of alohtone sediments at the level of lake basin (***Fig. 72***) (*Pop, Oana, 2010*).

Accumulation lake – upper lake view Accumulation lake – view towards dam

Fig. 71. Technical and perspective elements of Călineşti-Oaş Accumulation

6.1.3. Controlled flooding – a measure for flood attenuation

An important aspect in combating induced effects of water stagnation and excess is the sporadically use of lands as enclosures for floods. Thus, on the Tur, Someş and Crasna rivers were identified several territories that can be used for controlled flooding (***Table 64***).

Table 64. A synthesis of available surfaces for controlled flooding

No. crt.	***Water course***	***Flooding area. Characteristics and capacities.***
1	Tur – Micula Halmeu area – lot 1	Available surface – 1309 ha / Storable water volume – 15,7 mil.mc / 150 houses, arable – 1022 ha, meadows – 40 ha, forests – 150 ha
2	Tur –Micula Halmeu area – lot 2	Available surface– 2287 ha / Storable water volume – 34,3 mil. mc / 170 houses, arable – 1921 ha, meadows – 180 ha, forests – 110 ha
3	Tur –Turulung Vii area	Available surface - 649 ha, Storable water volume – 7,8 mil. mc/ 8 houses, arable 321 ha, grasslands – 320 ha
4	Someş –Lunca Apei area	Available surface – 1482 ha, Storable water volume – 14,8 mil. mc / 210 houses, arable – 1168 ha, grasslands – 200 ha
5	Someş –Băbăşeşti area	Available surface – 479 ha, Storable water volume - 7,2 mil. mc / arable – 329 ha, forests – 150 ha
6	Crasna –Căpleni area	Surface - 52 ha / Storable water volume - 1,5 mil mc / grasslands – 52 ha
7	Crasna –Ghilvaci area	Available surface – 733 ha, Storable water volume – 14,6 mil.mc / 40 houses, arable – 576 ha, forests – 127 ha
8	Crasna – Supuru de Jos – lot I	Available surface – 287 ha, Storable water volume – 5,7 mil.mc / arable – 285 ha
9	Crasna – Supuru de Jos – lot II	Available surface – 398 ha, Storable water volume – 7,9 mil.mc / 20 houses, meadows – 386 ha
10	Crasna – Ghirişa area – Răteşti	Available surface – 622 ha, Storable water volume – 9,3 mil.mc / 30 houses, arable – 300 ha, meadows – 297 ha, forests – 6 ha

As an example was chosen in this summary the controlled flooding area associated Someş River on its right bank, around the towns Potău – Lunca Apei and Băbăşeşti (***Fig. 75***).

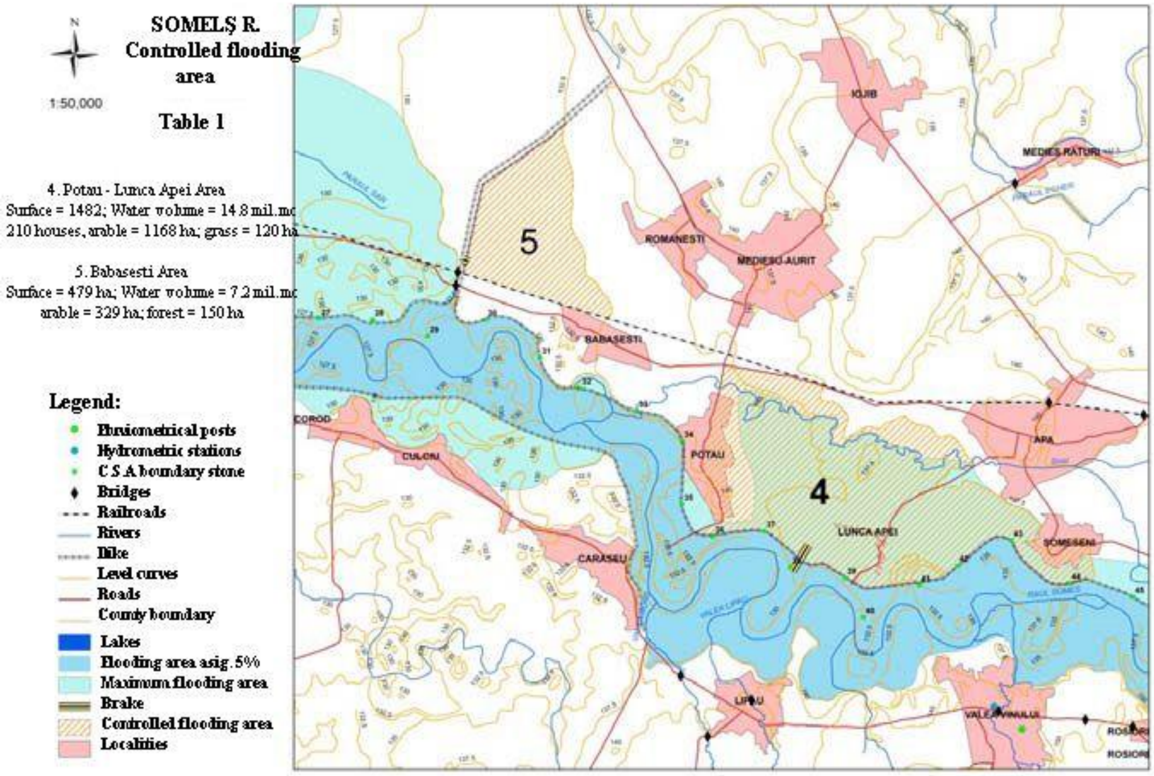


Fig. 75. Someş River – Board 1. Controlled flooding area (PMBH Someş - Tisa, 2009)

6.2. NON STRUCTURAL MEASURES

To limit the effects generated by water excess, was considered useful to assess local public perception in relation with stationary hydrological phenomena and processes, creating a complex questionnaire.

6.2.1. Stagnant generated water risks phenomena and processes perception. General considerations

The perception study of partly affected people by flood risks in the localities on the Somes Valley between the confluence with the Lăpuş River and Satu-Mare is a a quantitative research based on a structured questionnaire designed for this purpose and applied in the spring of 2005.

6.2.2. Flood risks perception. The questionnaire's result

6.2.2.1. Identification data

600 subjects answered to the questionnaire's questions, residing in 30 villages, all located on the Someş Valley. The duration of living in an environment, together with other factors, have influenced the perception of some extreme events. As a result, the floods are perceived differently according to the location of households in areas with different degrees of exposure to the extreme event. Therefore, the subjects were chosen according to this criterion. The respondents have households located in areas with different degrees of

exposure to flooding. Thus, of all people surveyed, almost all have households located in the highest risk area (92.16%), corresponding to the river meadow. The remaining 5.17% and 2.67% of subjects with households located on the slopes and terraces, live in areas with lower degree of exposure to floods, meaning areas with low and medium risk.

Hazard perception is a complex process that forms at the junction of several factors, including social ones (age, sex, education level, income, etc.) and has an important influence. The experience and attitude of the individual to extreme events depends on age.

6.2.2.2. Level of experience, cohabitation and information

The experience gained in time, while with direct personal knowledge of the previous hazard events, has a dominant influence on the floods perception, by offering a more precise imagine of the likelihood of their future appearence. Past experience is closely related to other factors such as the present attitude, personality, hope in the future, population preparing to these risks and traditions of government intervention. Of those surveyed, 49.67% stated that they were not affected by floods, and the remaining 50.33% said they had trouble following those events in that they were affected to varying degrees, both suffering from damages and wounds. In this situation, differences occur at the level of 30 localities, resulting from statistical survey processing in the studied region (the system of settlements along Someş Valley between Lăpuş River confluence with the Someş River at Satu-Mare).

After testing readiness to leave the locality (region), resulted also interesting conclusions. Thus, more than half of the interviewed subjects (66.83%) think that the flood risk is not a reason to leave the region, only on the recommendation of the authorities, saying that it will only create panic during the crisis; but a fairly high percentage (22.5%) is represented by the people who want to face the flood. Regarding the percentage that would leave on their own initiative the house / region is very low (10.67%), resulting in that the locals could hardly separate from what they have built in a lifetime.

FINAL CONCLUSIONS AND PERSONAL CONTRIBUTIONS

The presentation of a scientific paper's conclusions is the last stage of the research, a very important moment because it highlights the quintessential results taken during the entire period of research.

In theory, the main personal contributions are directed to the knowledge of the research domain, and embodied in the following directions:

- *Systematic clarifying of the studied region's importance* in the physical-geographic country context in terms of extreme hydrological phenomena and associated risks manifestations.
- *Hydrological risks phenomena analysis* that is certainly a major current problem of human society, and knowledge about their appearance and manifestation, on the level of causes and effects, and it requires a more sustained comprehensive approach. In this regard, it was considered important the scientific approach of water excess by addressing its evolution, shaping, defining and characterizing as a the hydrological risk phenomenon, along with a presentation of phenomenon's main prevention and control measures.

- *The presentation of methodological aspects regarding water surplus evaluation.* In this regard, first was attempted a definition and classification of risk phenomenon, followed by a presentation of its main assessment methods used as "*water balance method*" and "*evaluation methods of pluviometric exceeding periods*."

Personal contributions **to the empirical level** are important for those in water administration and management systems, as well as for decision-making authorities available at county, regional and national level in terms of decision-making if such hydrological extreme events and their associated risks appear, together with measures to prevent and combat them. They are represented by the results obtained from the research:

• *Identifying the link between* water balance components, the relationships established between them and the risk phenomena generated by water surplus obtained by calculation and interpretation. Research conducted on the components of the water balance reveals an uneven distribution in time and space, among them, determined by geographical particularities of the studied area, correlated with the basins' average altitude, highlighting the basic laws of water resources formation in the Someş Plain .

The nuances that occur in the spatial distribution of rainfall and runoff at the plain's level are imposed especially by **the peculiarities of air masses circulation** and **by the relief**. The spatial distribution analysis of the main water balance components was made on the altitude steps, both in the main river basins, and also at the level of plain's geographic subunits.

• *Determine the water balance components based on specific calculation methods* for each parameter.

To obtain **precipitation map** was used **TIN** interpolation method (**T**riangulated **I**rregular **N**etwork) and the "**Thiessen Polygons**" method (**Voronoi**). In the hydrographic sub-basins, reported at intervals of altitude, the highest amount of rainfall it received by the Homorode Basin, with an annual average of 600 mm, followed by the Someş Basin (585 768 mm) and Tur Basin (583.614 mm).

For **the average flow analysis** were used for observation data from nine gauging stations, which control hydrographic basins with altitudes ranging between 251 and 534 m, and area ranging between 69 km² and 15 600 km². Following the results, it is worth noting that almost the entire drained water volume (79.6%) from the rivers of Someş Plain originates from the altitudes between 101-150 m. Following the chronological variation of the average annual flow between 1979 - 2004 at all nine gauging stations from across Someş Plain, it can be noted that the highest flow value was in the year 1980. Other years with rich flow were 1995 and 1998 in Tur Basin, 1998 and 1999 in Crasna Basin, 1996 and 1999 in Ier Basin.

• *The identification of links* between results obtained by calculating the water balance and hydrological risk phenomena determined by water excess in the studied region.

The risks induced by water excess in the Someş Plain, which is can be felt either directly or indirectly, are linked to potentially catastrophic events, having a direct impact on society, thus constituting the main subject of the thesis. These are: **floods, soil water excess, sloughing and phreatic water pollution**. In terms of seasonal flood frequency, several cases are highlighted, with a maximum for spring floods (36-46%) in the Someş and Crasna basins, registered at Satu Mare, Domăneşti and Supuru de Jos stations, respectively a frequency maximum during winter in Tur Basin (40-52%) at Păşunea Mare, Gherţa Mare and Turulung stations.

• *The execution of a flood risk map* represents a documentation that includes (written and graphic) floodplains at different probability of floods producing, indicating the potential human and material damages for administrative - territorial units affected by floods.

• *The implementation of prevention and control measures* of the risk phenomenon through hydrological warnings or alerts (yellow, orange and red code).

In the Someş Plain, the incidence of hydrological warning messages targeted the alert of the following phenomena that may cause damage to society:

Levels increase with possible reaching of attention levels;
Floods propagation;
The formation of rapid flood with local effects on small rivers;
Large flows on the slopes, torrents, streams with local flooding effect.

The anthropogenic component provides the most dynamic factor of the geographical landscape, but also the most vulnerable to extreme geographical phenomena, suffering casualties.

In an effort to prevent and control the effects generated by extreme events in the research area, priority should be given to raise public awareness about the correct perception of floods and their responsibilities at individual, community and local administration level.

The harmonious integration of the community into the environment can be made only on the basis of a proper education that should involve several responsible factors.

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