# Environmental control of torrents environment: one valorisation for prevention of water flood disasters

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## Abstract

In this article, emphasis is placed on Environmental Planning and prevention of water flood disasters because of problems arising from the application of Directive 2000/60/EU. Thus, a study and a review are conducted, both on the way in which the climate (water) acts upon the space, aiding significantly in the methodology of partitioning, and the relationship between the environment of streams or torrents and its factors and human activities. The question posed is the following: *How and with which methods can be achieved the best environmental connection and use of torrents on Environmental planning, when it is well known that torrents in Greece are greater in number and cover a greater area than rivers?* Towards the end, various viewpoints of other researchers are presented, which methodologically lead the present article to a new method of approach, deriving both from the way in which the question of water is dealt with, with respect to prevention of water flood disasters, together with human structures for Environmental Planning, and from examining the merits of many applied examples.
*Keywords: Environmental Planning, influence of rivers and torrents, valorization for prevention of water flood disasters.*

## 1 Introduction

In this article is given accent in the Environmental Planning and in the avery of natural destructions, on the occasion the emerging problems of application of Directive 2000/60/EU, up to date because the discrimination-divide of space,

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when it is sought (objective) to be achieved the "good condition" for the undergrounds and surface waters, more late until the end of 2015 [1–5]. Concretely, an interdisciplinary environmental control for the torrent environment through the science of climatology is studied, when it is also connected with the human activities. It describes videlicet the 'how the water shapes space' and how various researchers involve torrent basins and how they face it in the way of segmentation of research: In wider totals or smaller segmentations (contributing, watergullys, regularly points etc), Kotoulas [6]. The question that accordingly is placed here is: *'In whom methods it can lead a researcher and how can be involved and be used better in the Environmental Planning the torrents environment, when it is known that these in Greece are redundant comparatively with rivers and also in extent and in number?'*

In the second part of this article becomes an evaluation and they are recorded examples and opinions of various researchers with regard to the way of approach and solution of the problem of natural destructions avery and the hydrologic problems, that result in the research. It is realised that, in the case of torrent basins are presented difficulties and uncertainties of approach, while is distinguished the fluvial system from the torrential environment. For overshooting-solution of problems that is presented, as is *the* turbulant flow, it is judged that with the approach of *local degree of torrent venturousness* with areas A, B, C, D etc, on the basis of certain constant points of torrents cross-section, can emanate a first simple arrest of avery planning. Thus, the present article focuses its interest in the final conclusions evaluation of avery of natural destructions, and flood-preventing protection in the torrent environment, at the same time with the involved anthropogenic activities on behalf of the Environmental Planning when these function in the research, it is seeking so much the better determination of methods and control of uncertainty of hydrologic control, as much as in the segmentation of space.

## 2 Environmental control for the torrent environment

In this part, becomes an environmental control on behalf of more the *"torrent potential or environment",* through the science of climatology, as also and in how this is connected with the human activities. The foresters write that the torrent environment, is determined by the combined energy of four basic factors, *"climate, geological bedrock, bas-relief and vegetation",* which functions as mechanism of action of direct torrent factors, while the endogenous forces acting as indirect factors. If they are added however in the regulation of torrents, the fauna or the work and the energies - actions of human, then these are considered direct factors and the torrent indirect, because the each placement in this question depends from whom side it is seen [5–7]. The torrent phenomena are distinguished in *hydrologic and landmass transportation*. The initial reasons of torrent action are mainly climatic. They develop in the high layers of atmosphere and have relation with thermodynamic changes in the wider climatic space. There, it is regulated the frequency, the duration and the course of temperatures, that prevails in the space of each water stream. These factors mainly regulate the

*diet of* the torrent. By the rain quantity and the time distribution, is influenced the action of factors and accordingly the diet Brown and Brandley (in the Koutseris [8]). The torrent phenomena, that are attributes of the torrent, are distinguished in action that concerns the avery of destruction. The intensity of phenomena determines torrentcy. Each torrent allocates a concrete water potential, which is determined by the composition and the interaction of torrentcy factors (climate, rock bed, bas-relief and vegetation), [9, 10]. Consequently, each torrent, depending on the situation of torrentcy factors, shapes watercourses capable to receive, channel and neutralise the water flood charges, which produces and dispatches the mountainous space. Consequently, under natural conditions it exists, a dynamic balance between the producer highland basin and the channelling network (watercourses), which are expressed in the size of geometry and in the particular characteristics of each watercourse. Therefore any disturbance in the conditions of mountainous space will force the watercourses to be adapted in the new environmental data. This adaptation is particular violent and dangerous, when drastically is altered one or more torrent factors. In this variability and the adaptation of geometric elements it is located the interest in the present variability [4, 5, 11]. After befalls this variability, the situation has changed. Consequently it is again required measurement and study of torrent behaviour, taking into consideration the new data; so as to they are proposed eg certain metres of regulation or recognition [12, 13]. The planning of the lowland regulations had to be based in water landmass-loads that the highlands space is unable to neutralise or suspend, provisionally or permanently. On the contrary, the control of human activities does not depend absolutely from this variability of natural elements and characteristic [6, 11].

The same accent in the highland basins and in their control, they also give the land-planning engineers, when they are planning land reclamation works that concerns the flood-preventing protection and the protection of soil from the erosion, stressing the important role that they play the work of highland basins and water streams regulation, because they receive the transport of brought materials in lowland (flat) areas, that is affected by floods. Also these brought matters are devastating for flood-preventing work [5, 14]. Here are included according to land-planning engineers and the artificial lakes or weir reservoirs, while in other point is blamed the torrents filling with debris, as anthropogenic action, which often leads to the phenomenon of urban water floods. As innovative approach is proposed also the withholding of waters in the underground tanks through water permeable layers [8]. Today, the torrents and the rivers are increasingly imported in the studies and researches of environmental planning and upgrade of basins regions (Maliokas *et al*, Municipality of Stayroupolis in Koutseris [8], [3, 5, 12, 13]).

The quantity of rain water exists with its flow in the low important losses, because of the evaporotranspiration and the infiltration. Evaporotranspiration depends from the climatic conditions, while infiltration from the geological rock bed. Both are encouraged by vegetation (Brown and Brandley in Koutseris [8]). As for the landmass transportation torrent phenomena, the initial reasons of torrent action are the same with those of hydrologic, with alone difference that

the flood force of water as kinetic energy, when it becomes so much intense, so that it exceeds the resistance of geological rock bed, begins to extract and to drift materials from water. As emanation it comes the erosion and mine corrosion. Here, important role plays also the temperature (Horton fusion and coagulation in Koutseris [8], [4]). However the four torrent factors, independent from time (e.g. land or humid period of one hydrologic year), function differently. The measurement of water flow in a concrete place - cross-section at the time moment of a rapid rainfall, does not mean that the flow of torrent is the one that results from measurement (André, Audinet, Mareran, Richter in Koutseris [8]). In the various points the benefits are different. Differently functions the torrent in the arid period and differently in the humid period. The segregation in two water periods becomes in September, when the underground waters are found in the lower point. Consequently, a big part of waters of torrent basin leaches in the underground water-bearing stratum, one smaller part constitutes the waterhold capacity, a third part the passing through rain, an other which depends from the passing through rain percolates in the soil (wetting) and finally, a big part exists the evapotranspiration. The rest flows via the drainage network [8, 15]. Often at the research of hydrologic subjects, which becomes for aiming at the avoidance of flood, or as necessity of water, and which include beyond the morphometric and drainage factors, the control of human activities, the relative scientists apply in study of the torrents and the known evolution stages of the Davis theory (the geomorphometric scientist) [6, 8, 15–17] or as it is differently named, *the"theory of* erosion cycle*"*, *"for youth, maturity and old age"* [15]. It is known that, with the theory that was hardly developed a researcher can compare various torrents basins between them, but mainly standardise along at torrent cross-section (of main watercourse and then the contributing water streams) of each torrent, after they are determined first the regions, where takes place the "renewal" (landsmass rejunevation) [17] and accordingly and controversial regularly geometric points, which could create destructions (or profit) in the future (Gonzales *et al*, Whitton, in Koutseris [8]).

From the above we are in place to lead in a first conclusion that, the intense and frequent variability of torrent environment impedes the researchers to apply in the Environmental Planning methods of reconnaissance and determination. Thus, obligatorily many resort in more rapid and simple, but not so much precise methods. The control would be better, if they were realised whether with repeated measurements in the renewal points, or with the application of a permanent model of physiographic variability, which is a thing however completely difficult (Boshes, Leopold, Wolman, Miller, Ducan *et al* in Koutseris [8], [11]). With regard to the hydrologic control it is observed and is also realised in a lot of publications, that, as long as anyone is transported in the research from the rivers into the torrents, so much are increased the difficulties and the uncertainties of variability, while on the contrary the morphometrical characteristics, as physiographic static elements, are checked enough more easily. As such are considered the area, the form, the perimeter, the roundness degree, the minimal, biggest, medium and biggest torrent altitude, the biggest bas-relief, the medium slope of the torrent basin. In extension and the

hydrographical characteristics are checked more easily, as the form, the density of drainage network, the length of central watercourse and the medium slope, as they prove older researches (Smith, method of Ven Te Chow, Henderson in Terzidis [18], Ampa's *et al* in Koutseris [8]). In spite of, in these regularly or geometrical points that exist, anyone can resort, before he is turned in chaotic or holistic ways of approach of unexpectedly and asymmetrical natural phenomena. Thus, in the present article the hydrologic control is focused only in the avery of destructions that it is probable to cause a torrent, while the water saving and the regulation via work or the development stages in the "renewal" (landsmass rejunevation) points of the Davis theory or others geomorphometric scientists, lead to certain regularly geometric points, that can occupy us elsewhere [5].

## 3 An evaluation of hydrologic control and avery of destructions for the environmental planning

Up to now in the previous part it was studied and checked, how the water shapes and distinguishes geometrically the space in torrent environment concerning the human activities, for their better comprehension in the hydrologic control. In this part, is faced the question of water from the side of destructions avery and is examined an evaluation of hydrologic control when it thus concerns the human manufactures for environmental planning. In this way, they are recorded and then they are evaluated examples and opinions of various researchers for the way of approach and solution of destructions problem and any hydrologic problems that they result in the research. In this optics indeed, in the torrent basins result difficulties and uncertainties of approach, as it was pointed out and before. It is another thing the fluvial system and another the torrential system.

A lot of scientists-foresters working in flood-preventing protection [15], proportionally and with the land use of river basin, they apply a general method, the known relation of rain-runoff of Soil Conservation Service (SCS) of the U.S.A., where the statistical informations are exported, while on the classification of land follows once again a internationally recognized method, which is conform with the Address of Agriculture of USA. (USDA, Vouzara's in Koutseris [8]). Other, mainly engineers, for the flood-preventing protection of Thessaloniki [19] proposes bunds and tanks of interception in the regional ditch and in Dendropotamos [15]. In which methods however it will be supposed to use anyone, when it is known that in Greece are also redundant in extent and in number the torrents despite the rivers? Objective problem constitutes that similar international methods do not attribute, because the particularity of climate. From the examination of Greek bibliography it resulted that, many deal with the rivers and few with the torrents. Other mainly geologists are again reported in the fluvial environment and in the climate, the topography, the tectonics, the rocks and the soil, while it fixes the volume of water per unit of time ($m^3$/sec) of flood discharge. They deal, that is to say, with the flat regions and mainly with certain basic factors that were mentioned before, but no with the vegetation or the fauna. That is because; a lot of them are interested in the floods only in lowland areas. The term stage of flood, that is to say downhill, declares that when the level of

water goes up more highly from regular, they can be caused destructions in the sprawl basin (or cone of illuviation according to the foresters). More they write also, that the floods depend from three factors: a) the total quantity and distribution of rain, b) the permeability of the rock bed or soil, c) topography [20]. The total quantity and distribution of rain can be approached, the permeability of the rock bed or soil can be approached with difficulty and for the topography important role plays the highland basin. With the last one be occupied with at least, so that is neglected the vegetation? This omitting even if the discussion concerns rivers, because also these include torrents (eg Pinios river with its torrents), is not justified without the total basin, as it resulted from the first part. Each torrent has its own personality the foresters write [7], while it is required today as long as never an early warning system, based on the recording of elements. The data, however, continuously change, even in the torrent itself e.g. the surface run-off is increased with the urbanisation, because smaller quantity of water infiltrates into the soil (time delay-rural with urban regions) and consequently grows the danger of flood [20]. When today the cultivations (e.g. cereals) are replaced from low density residences, the forecasted surface water run-off and the floods with a repetition period of 2-4 years they become more intense, while these with a repetition period of above 4 years can be less intense. They change, that is to say, the data. Hence, the change in the land use affects through the permeable or non-permeable surfaces and increases the danger of flood [20].

From the environmental opinion, the geologists write that in the urban regions the minimisation of destructions from the water floods are checked by the configuration of sprawl basin, that is to say by the cone of illuviation. Because the urban accumulation, the weight of scientists falls in lowland areas. However, the regulation of torrent basin in the highlands can suspend the water floods and this becomes a difficult undertaking for the state and here it owes to insist a researcher: In the reject of awkward water floods from the highlands. Thus, the confrontation of destruction is based, according to certain engineers, on some legal frame (not technically), with certain obligatory expropriations on the corridors of flow, so that allow alluviation or sure from flood manufactures in the region of utmost corridors of flow [20]. At their opinion, two sectors that are cartographized in the region of venturousness it is: a) the region of corridors of flow and b) the region in utmost these corridors [20]. Even if they do not determine more if the mapping concerns river or torrent, they lead to the conclusion that, while it is not always feasible in practice, the channel should allow in the waterstream to coil, providing alternations of fast flow with small depth and slow flow with big depth. Also, the erosion of slopping bank should be checked completely, while the exterior sides of manoeuvres of waterstreams should be protected with big Stones, known as zip-zap [20]. In the last years, the water flood venturousness does not threaten more the big lowland (flat) extents, however various reasons, shows that it has by far increased in or in the limits at residential areas. The water flood events in the urban regions are increased on account of the inactivity and the procrastination of city residents [20]. Even if the discrimination in fluvial and torrent environment is important, the fluvial it does

not interest the present article. Moreover, in the hellenic space are redundant the torrents and these are that cause most natural water destructions. In any case and for the two systems is required a system of early warning, based on the recording of elements. Also, in the two systems change the data, particular however in the torrents, because and the change of land use and unconformable water flow.

In the torrent hydrology the aquatic currents are distinguished by the torrent-engineers in four types [21]: a) *headstream:* Damage only from "clean water". They are checked with the "use of known technical calculations". b) *Torrents of hilly and semi-highland regions:* "More usual case in Greece" with proportion of landmass transportation and water "smaller than 10 until 15% roughly". The measurement becomes in alignment segments of watercourse "with constants generally cross-sections, bents of watercourse bed and roughness of watercourse and banks" [21]. For landmass transportation they can be applied the types of Meyer-Petter and Muller of Einstein, of Schoklitsch, of Pedroli *et al* [21]. c) *Torrents of the highland and very highland regions:* "They are characterized by intense torrent potential. The percentage of landmass supply concerning the water supply is big, oscillates between 15 and 30% or more seldom and up to 50%... it doesn't' follow the lows of Newton's humids… the mechanism… is not today sufficiently known. Consequently, the hydro technical calculation cannot help us in this case". However, in case neighbour of Newton's flow that landmass supply does not exceed 20-25% of the water supply it is possible to become forecasts… with uncertainly however results, while other methods are approximate [21]. d) *Torrents*: here are 50% the above proportion therefore the mix "behave as plastic material" and it has the characteristics of "volcanic handholds", while it is observed that "for low percentages landmass supply as for water supply they only can be overflowed the following disadvantages" and only with effigies. The next time or the next period, the torrent has suffered changes and a new situation dominates, therefore is required also new calculation and measurement. Into account must be taken that in the torrents we usually have turbulant flow, that is to say chaotic [21].

Before we approach a final evaluation of the above discussion, they are mentioned by other scientists various approaches of problem confrontation of territorial segregation surfaces in the venturousness, mainly of the torrents, with certain characteristic examples of methodology for avery destructions with segmentations based on the torrent basins.

*First example*: At the study of "meteorological data, concerning the production of brought materials and water flood genesis" in the torrents, Stathis [22] for the prefectures Kastoria, Grevenas, Kozani and Trikalas, with a total extent 8,412.2 $km^2$, separates six big totals of torrent basins [22], as well as stages of height [22]. In his final conclusion the Stathis [22], "with base the factorial charges of two factors", separates the entire region in "four areas of rainfall" in Koutseris [8], [22].

*Second example*: Studying *the flood in Fourka Chalkidiki,* Pavlidis [23] cross swords with the run-off basin of torrent, which he separates it in smaller basins F5, F4, F3, F2, F1 [23], in order to "is permissible the diagnosis of water flood risk endlong the stream" and "is determined the local degree of torrent

venturousness" with such way, so that to be "hierarchical time-spatially the necessary works of regulation" [23]. With the examination of the morfometric and hydrologic characteristics of the total basin and of the torrent environment [23] it determines the route time of each subasin, the biggest rain height, the intensity as well as the landmass sediment, based on measurements of 5 cross-sections. In his conclusions are located regions of direct risk A, B, C, D and they are proposed respectively metres of regulation.

*Third example*: Similar segregation applies also the Pavlidis [23] in the study of flood-preventing protection and environmental reformation of Rematias and of Pararematias region of torrent Kryoneriou-Sykeon, calculating for a period of reintroduction 2-50 years, and 10 years for the rainfall and the brought materials in each sector of torrent (Eastern, central, western and central watercourse), based on two affairs: total and partial destruction of vegetation [10].

*Fourth example*: A exclusively engineer-climatologist interests more for bigger territorial surfaces, without these to be of run-off basin level, and it can use modern "digitized measurements of rainfall" via radar, for flow simulation (Dalezios in Koutseris [8]).

*Fifth example*: the estimate of water flood run-offs and the flood routing attempts also Sakka's in [3]. It uses unit hydrograph and hydrologic complex ground-vegetation cover. He applys it in the water flood of 18-19/11/79 in regional ditch of Thessaloniki [8].

*Sixth example*: Kotoulas [21] in the subject "Contribution in the forecast of behavior of torrential waterstreams in the region of cone of illuviation and watercourse rehauls" writes that, first systematic effort for the precise forecast of behavior of torrential waterstreams in the cone of illuviation, "became from Aulitzky (1972)". It distinguishes the aquatic streams in "dangerous areas" (Gefehreuzonen), with the help of "muted witnesses", that is to say the results that caused previous loss-making action [21]. From all the above and from the characteristic examples here result the following final conclusions of the evaluation.

## 4 Final conclusions of avery destructions evaluation and flood-preventing protection

Evaluating interdisciplinary the above approaches they can be distinguished first certain ascertainments before the final conclusions. In Land planning, in other countries, as segmentation, except the administrative limits, is particularly applied for the hydrologic planning and the segmentation with torrent basins. In Greece, even if the country is deprived to a large extent the regulating protective faculty of vegetation cover and even if it is characterized from multifarious anaglyph with small extensive plains, that it has as result the torrents are still not changed by no means in mildly and big rivers, in the frame of Mediterranean climate, many in the Planning do not take into consideration in the researches and studies the torrent basins (as the *planning* of destruction avery). Nor however the limits of watersheds are used *as method of segmentation of space*, while they are still least used the torrent space segments or bio climate

(temperature-rain), or the density of drainage network or the highland and lowland (flat) density. Such an example of omission discovers no one today in the segmentations of regions 'Nature 2000' [3]. It was realised that an element that impendes the forecast-warning in the torrents, is the difficulty of solution of turbulant flow in them. Thus many resort more to empiric methods of approach (dangerous areas, muted witnesses etc), despite in Unit hydrograph. But in the substance, result also variant opinions between the scientists, as for the solution of flood-preventing problems. The foresters in the torrents use the segmentation in torrent basins or units, resorting not only in empiric, but also to analytic methods, as maps of isocurves, homogeneous areas of rainfall, ombrothermic diagrams, height stages and isothermic curves. The 'plumbers' for their part prefer more analytic methods. The general discrimination of torrents in four types proportionally the flood genesis or their landmass transportation, becomes very useful. While the climatologists often ignore the torrent basin.

For overshooting-solution of the above problems of turbulant flow, it is judged that with the approach of local degree of torrents venturousness with areas A, B, C, D etc, based on the constant points of torrents cross-section, can emanate a first simple approach of avery planning ([1], Terzidis and Anastasiadou, 1973 and Anastasiadou-Partheniou, 1986 in Pavlidis [23] and Terzidis in Koutseris [8]). Hence as for the methods of water flood avery or in the flood-preventing protection is concluded that:

1. The factors that check the destructions in torrent basins, that are caused by floods *in the rivers,* it is determined from the land use of sprawl basin, the size (depth and speed of water) and the frequency of flood, the rhythm of elevation, the duration of flood (season - weight of sediments) and the forecast-warning. In the substance, are proposed *configuration of sprawl basin* and determination of the critical factor. That is to say, while in the rivers it can be used so much numerical methods and also qualitative, *in the torrents,* because of the hard to solve turbulant flow, anyone can resort for bigger convenience, to the discrimination with the dangerous zone-areas, based in the muted witnesses (qualitative method) or at least, in unit hydrograph and the hydrologic complex ground-vegetation cover [5].

2. The proposed in the previous part methodology of segmentation, that is to say the approach of *local degree of torrent venturousness* based in certain constant points of torrents length-section, is judged as the more equitable and practical way, with which are determined the route time for each subasin, the biggest height of rain, the intensity and landmass supply. This degree of venturousness is based on measurements of cross-sections, where are located the regions of direct danger A, B, C, D, while they are proposed respectively regulation and metres, without also to be ignored the existing legal frame, that approaches the region of flood level of 50 and 100 years, with the route region and the region of utmost route of flow [5].

3. The climatic data can also be depicted with homogeneous zone-areas of isoarithmetic rainfall and isothermic curves that is to say with the Thiesen method, the method of contour lines and the Ombrothermic diagrams. It can be preferred also in the environmental planning, as practice and direct need

solution, the discrimination of aquatic streams in four types, which was mentioned before: a) *headstream* (without *landmass transportation*), b) *Torrents of hilly and semi-highland regions* (*landmass transportation with* big intensity), c) torrents of *highland* and urban regions (*landmass transportation in* big extent), d) torrents (*landmass transportation*) [5].

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