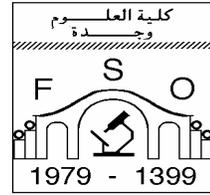




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Biotic Components of an ephemeral stream in Mediterranean: Study case of the Zegzel-Cherraa system in Morocco

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Introduction

Five factors govern Mediterranean ephemeral streams in their basin: Altitude, longitude, climate and geology. This is a common feature of the Mediterranean ephemeral rivers that have irregular flow, with difference according to the tributary (Ghasith & Resh.1999) . Many are dry or half dry or carry little water during the summer drought that often lasts several months and flow again with occasional spates during the rainy season. In Morocco, Mediterranean ephemeral rivers are in fact short torrents that descend generally from the mountain and receive few tributaries (Chergui and al. 1999).

Precipitation is a major factor controlling the hydrology of the Mediterranean region. Rainfall is irregular at different scales in the basin of south Mediterranean. The number of days of rains is as example in north-eastern Moroccan between 40 and 70 days per year; generally, they are violent stormy showers of short duration from December to March. There is not average year but rather succession of dry years and wet years. As a matter of fact, the south Mediterranean receives in general little rain. Fauna and flora Co-evolve with the climatic changes. A rainy year presents generally a high biodiversity in the ephemeral streams and riparian on the other hand a dryness year is generally followed by the loss of the biodiversity.

The knowledge of rainfall patterns in space and time and rainfall statistics is essential to an understanding of soil moisture, groundwater recharge and river flows (Ward & Robinson , 1989)

The Zegzel-Cherraa hydrosystem is a representative Mediterranean ephemeral stream which was selected in Morocco within the framework of UICN's Workshop on the assessment and provision of environmental flows in Mediterranean Ephemeral and Intermittent streams that will take place in Madrid (Spain) in September 2004.

I. Description of the Zegzel-Cherraa hydrosystem

The Zegzel-Cherraa hydrosystem is subdivided in three sections (Fig.1) which describe the major characteristics of the different types of ephemeral rivers, that is:

- one that flows all the year round but sporadically dries out,
- one that dries every year during a specific period of time,
- and the last one, that it is always dry but has a flow every now and then.

i- The Upper section

The Upper section called "Haut Zegzel" is located upstream in a mountainous forest at 435 m of altitude. The stream is fed by the Liasic springs of the Zegzel. They are limnocrenous springs of Laghlalcha; Ain Bourbah (spring of the "Camel grotto" and Ain Hallouma whose flow varies from 10 with 100l/s according to the season. These springs respectively feed the Western Southern branch of the Zegzel, Ferrouj and Moulay Idriss ensuring the perennial character of the Zegzel stream. In this upstream zone, the temperatures are more stable (19 to 25°C) that downstream. The flow is relatively fast (0.75 m/s on average) during the winter period, but becomes weaker in summer (0.25 m/s on average). The width of the river does not exceed 2 m. The depth with the low water level can reach less than 5 cm in certain places. It relates to a karstic system with very high permeability. Calcium bicarbonate in water is in connection with the geological substrate of the basin with a good oxygenation in this upstream zone maintained by the

importance of the flow and the turbulence. The substrate is formed by large semi-emerged blocks, stone rollers, stones and of sand with much of wood remains.

The aquatic vegetation consists of a few rare feet of *Chara vulgaris longibracteata*. Moreover, the cover algae are absent. The bordering vegetation is made up primarily of: Pink laurel (*Nerium oleander*), of willows (*Salix pedicelleta*), Reeds (*Arundo donax*) and Rosacea (*Rosa canina*) with some Ferns, Pomegranates, Plum trees, Fig trees, and Poplars (*Populus alba*). The slopes of the valleys are covered with *Tetraclinis articulata* with some feet of *Chamaerops humulis*, *Ceratonia silica* and *Olea europea*.

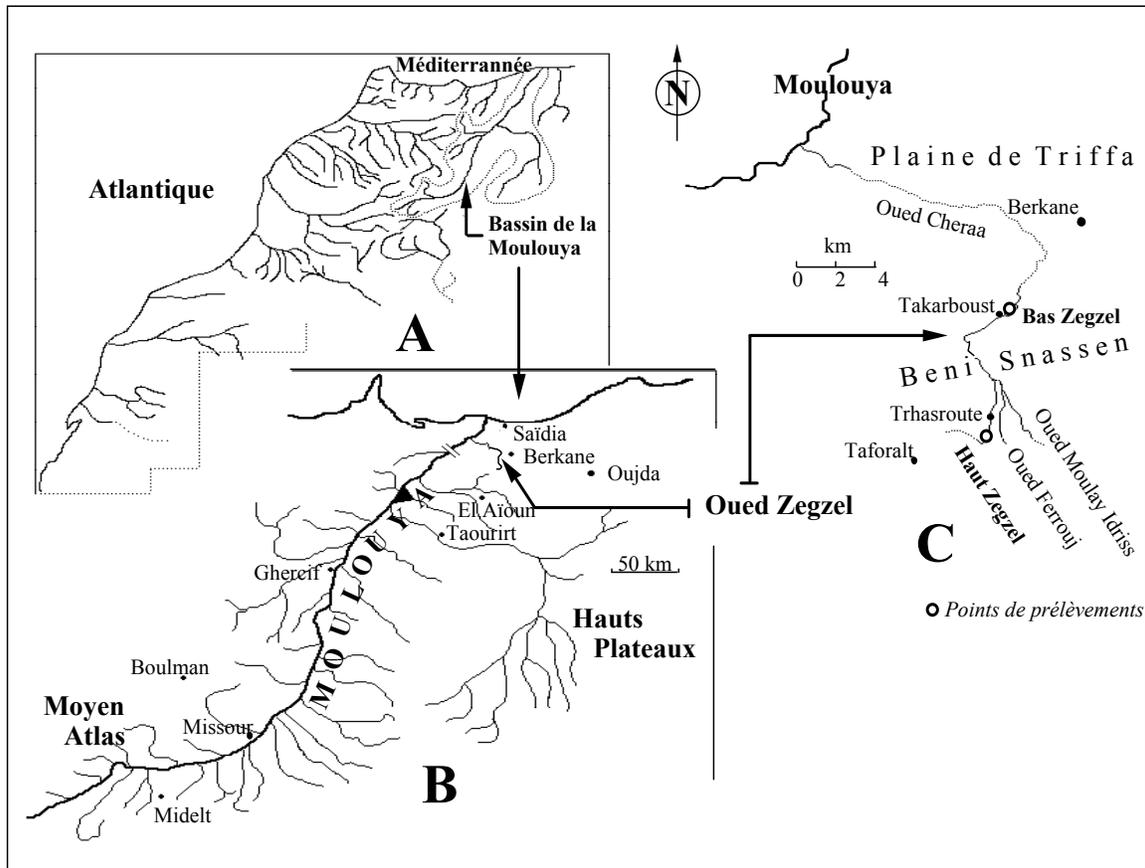


Fig.1.- Localisation of the Ephemeral Stream:
A: The basin of Moulouya B: The Moulouya river C: Zegzel-Cherraa stream

These characteristics of this part of Ephemeral stream have some repercussion on the ecosystem biological functionality of the system: A typical flowing water fauna inhabits the river during the rainy and cool period. It comprises reophilic insect larvae of the groups Ephemeroptera (*Baetis*), Trichoptera (Hydropsyche, Rhyacophyla), Diptera (Simuliids, Chironomids...), Coleoptera (Hydraenidae, Gyrinidae...) some rare species of Hydracarina, molluscs (ancylus) and flatworms (*Dugesia*) are also found among the winter communities.

All these species are many functions in the upper area of this ephemeral stream:

- Richness of the biodiversity
- Trophic function as food

- Biological function (degradation of the vegetation)
- Energetically function (Flow of energy)
- Maintains of biological quality

In the upper reach of this ephemeral stream species are not significantly different from the existing in Baseflow Rivers because the stream flows almost all the year round. The seasonal communities vary significantly. They differ much between winter and summer. This difference relevant for the good functioning of the ecosystem in winter and spring season but in the summer, it can be seen the bad functioning of the ecosystem. The seasonal communities can be used as indicators in this part of ephemeral stream by their density and by their presences/ absences.

In this ephemeral stream; flood events are unforeseeable and violent, this is due to the downpours of rains. These risings produce abrupt modifications of the abiotic factors, a strong fauna reduction and the disappearance of many species.

Riparian entomofauna was the subject of a diagnosis in Beni Snassen and more particularly on the level of this ephemeral stream (Chavanon, 2003) within the framework of the project Med Wet Coast in this protected area: The results show a great entomological richness related on the diversity of the riparian habitats and permanent wetland.

In the upper section Ichtyofauna is represented by original and greatly endemic *Barbus* population. For some authors, the genus includes two sub-genera (Melhaoui, 1994): *B. barbus*, which is close to the Spanish and European Barbel, and the *African B.Labeobarbus*. For others, *Barbus* and *Labeobarbus* are genera. These species are native of Morocco and they occur in all waterbodies inhabited by fish.

Box 1: Fish population in Ephemeral streams

The Mediterranean ephemeral stream has little interest in terms of fish, as its discharge is highly variable and its floods carry muddy water. It is inhabited by Cyprinids, mainly barbel of the genus *Barbus* (*Barbus callensis*) which finds trophic resources in the upper reach of this river. This is very characteristic to fish population of the Mediterranean ephemeral streams in Maghreb. In ephemeral stream, aquatic fishes have neither an economic nor gastronomic interest. We can see occasional mortality of fish probably allotted to the pesticides used in an irrational way.

This ephemeral stream shows a high biodiversity of, birds, herpetofauna and mammals (otters) richer upstream than downstream. This is linked to the habitat variability. One of the most dramatic consequences is the decline of fish population and invertebrate biodiversity. The stream suffers from the lower discharge and that is due to crop irrigation. Spring harnessing has caused the disappearance of many local species. Pumping of water is the cause of mortality of young otters.

ii- The Middle section :

This section called “Bas Zegzel” is located downstream from 280 m of altitude near the village of Takarboust and crosses the throats of Zegzel. The flow varies from 10 to 300 l/s. Jurassic Limestone’s constitute the principal geological substrate of the Zegzel and gives to water a calcic bicarbonate composition. The stream is temporarily dry there only on the level of the area of Tazarine upstream of Berkane where its flow is entirely diverted for the irrigation of the small perimeters cultivated in piedmont of the Beni Snasen. The phenomenon of infiltration of water is also partly responsible for

the draining of the stream on this level. At this level begins the Cherraa stream. The valley becomes more open. The current is weak (0.25 m/s on average); the water temperatures fluctuate during the year (11 to 26°C) because of exposure of water to the sun and the low minimum flow. The slope is weak. The width of the major bed is about 40m. This zone is subjected to excessive abstractions of water for domestic and agricultural uses (irrigation of the crops). In particular during the summer, the river feeds from the channels intended for the irrigation of the fertile terraces of the valley, which leaves a low flow in the bed of the stream. The substrate is dominated by rollers covered with filamentous algae with blocks and accumulations of sand and mud.

The aquatic vegetation consists of Characea and especially of phanerogames with floating sheets (*Potamogeton trichoides*). The riparian vegetation misses almost completely because of the strong rising which tears off, except some tufts of *Nerium oleander*, *Salix pedicellata* and *Tamarix balansae* which resist forming small islands along the river. On the slopes of the valley, one meets some *Juncus acutus*, *Equisetum* sp. and *Tamarix balansae*.

Box 2- Characea population of the ephemeral stream

In the Zegzel Cherraa stream, we find an association of Characea in lentic environments in this hydrosystem. The development of these precious taxa in spring depends on the very irregular hydrology because they do not tolerate prolonged immersion. The genus Chara is broadly diverse throughout the whole ephemeral north-eastern Moroccan streams. *Chara vulgaris* is an eurytopic and ubiquitous species on sandy or muddy bottoms. In these calcareous waters, calcium carbonate crusts cover this plant and reproductive apparatuses. These macroalgae contribute to water purification by retaining suspended particles in their phylloids. They provide oxygen for invertebrates and fishes. They constitute food for several herbivorous animals such as crustaceans, insects, gastropods, some fishes and birds. The distribution of the Characea in this ephemeral stream is clearly linked to the type of habitat and geology.

In this ephemeral stream, we can see in general the predominance of the thermophilous species. The biotic components of the systems (fauna and flora) deal with the temperature, evaporation and human disturbance and water fluctuation. They are adapted to this. From the very beginning of the winter, it develops an algae layer in the bed and especially on the edges where water is calm. In those sections that still have some water in summer, the cold-water rheophilic winter fauna is then replaced by more thermophilic fauna and limnophilic fauna similar to that found in other standing waters. With the exception that Crustaceans are generally absent while insects (Heteroptera, Coleoptera, Hydradeptera, Chironomid, Diptera, Odonata and Ephemeroptera) predominate. In this part of the ephemeral stream, the fauna is mostly limnophilic, even in winter. It is possible that the macro invertebrate fauna migrates upstream or present of the resistance forms.

The recolonization of this zone after the flood is ensured by the invertebrates remaining on the spot in the zones of refuge and starting from the contributions by the aquatic or air way (Berrahou. 1998). All these species have many functions in the lower of this ephemeral stream that dries every year during a specific period of time:

- Maintains of biodiversity
- Trophic function as food
- Biological function (degradation of the vegetation)
- Energetically function (Flow of energy)
- Maintains of biological quality

iii- The Lower section:

Called "Oued Cherraa", this stream drains three narrow and deep valleys in Beni-Snassen upstream of Berkane namely the throats of Zegzel, Ouartas and Beni-Ouaklan to join Moulouya to 12 km of Berkane. The Cherraa begins from Tazarine village with 200m of altitude near the town of Berkane with a completely dry bed in summer. Oued Cherraa soon enters the Triffa plain, passing it through it reaches the Moulouya River. This section of the river marks the temporary character of the stream. During certain periods of the year it ensures to stream a certain flow thanks to its liasic springs and thanks to surface waters at the time of the strong rains in winter and by the increase of the ground water. In summer strong heats (high evapotranspiration rate) cause the total drains of the stream and/or the reduction of the volume of water in certain zones. Little measurement of flow is available. Flow does not seem to exceed 100 l/s when water runs it is the continuation of the lower course of the drained Zegzel stream which runs only for the periods of the rising. From the meadows of the town of Berkane with a completely dry bed in summer derivation of water to Crops by construction the " Seguias " (traditional irrigation channels) intended for the irrigation from the terraces from the valley. The water handing-over is often brutal in rainy periods but as of August the stagnation of water takes place and the stream starts to be drained.

The exact duration of the dry phase varies according to the geographical localisation and local hydrologic conditions. For example, according to the rainfall, if it rains a lot, water is permanent and the duration out of temporary water can exceed the dry duration.

The Cherraa downstream is located at the beginning of the plain at 190 m of altitude. This station owes its immersion to the winter and spring risings of the Cherraa stream. During the flooded phase, the various sections of this station remain most of the time separate from one other. Water circulates from one depression to another through the coarse elements of the substrate without covering it completely. It is only during high waters that the various water collections meet to form a homogeneous river. During the month of June, the quantity of conveyed water becomes very weak then null, outstanding water collections more or less the large and isolated ones from the others which disappear little by little by evaporation and infiltration. This Cherraa station downstream is distinguished from that of the upstream by the duration of the dry period, the terrestrial presence of vegetation in its bed and its significant width being able to reach approximately 100 m in certain zones. The slope is very weak. The bed a length from 30 to 40 m is a mosaic of large blocks, rollers, gravels and sometimes of accumulation of sands.

Temporary water collections within this station are covered with filamentous algae. The vegetation of the banks is rather rare and made up primarily of *Juncus acutus*, *Tamarix balansea*; *Nerium oleander*, *Salix pedicellata* and *Populus alba*. Substrate is often covered with filamentous algae.

In this section that still have some water in summer, the cold-water rheophilic winter fauna is then replaced by more thermophilic fauna and limnophilic fauna similar to that found in other standing waters. With the exception that Crustacean are generally absent while insects (Heteroptera, Coleopteran hydradephaga, Chironomid, Diptera, Odonata and Ephemeroptera) predominate. In this part of the ephemeral stream, the fauna is mostly limnophilic, even in winter. Riparian fauna colonise the bed of stream. The recolonisation of this zone after the rising is ensured in general by invertebrate drift by air way. The discharge of polluted water from the town of

Berkane ensures a minimum of flow with a fauna and flora adapted to the polluted zones. The extraction of sands for construction is a disturbing factor of existing fauna.

Existing fauna has little but important functions in this section of ephemeral stream that is always dry as:

- Maintains of biodiversity
- Trophic function as food
- Energetically function (Flow of energy)

Derivation of water and gravel extraction activities are a very problem in this section of ephemeral stream and present a negative impact on macro invertebrate entomofauna: disturbance of habitats, fauna mortality and filling of water vegetation

b- Ecosystem functioning in Ephemeral stream

Compared with the studies made in the permanent aquatic ecosystems, the work done in the field of ephemeral streams is still far from advanced. At present, it appears that thorough studies are undertaken on the organic matter in the ephemeral aquatic systems.

Box 3 - Ecosystem functioning of Ephemeral stream

The Ephemeral systems have an organisation regulated largely by the physical features such as the water, whose dynamics, physical aspect and chemical composition intervene like organising factor of the whole of the ecosystem, both in its space (Heterogeneity) and temporal dimensions (instability). Generally, water circulation has a very significant role in the phenomenon of transport of matter and energy (plants, animals, mineral and organic material...). This transport is often in relation to the variation of circulation of water.

The hydrosystem downstream receives massive contributions of dissolved and particulate nutrients and fauna by drift. Like all the other aquatic systems the ephemeral streams, are not closed entities. Exchanges take place with adjacent elements indeed, and interactions can be established on the level of their common limits. The zone bordering or Ecotone, definite like the zone of the direct interactions between the terrestrial environment and the aquatic environment plays by its topography a significant role in the operation of the aquatic system, which in its turn influences the development of the riparian vegetation. Very narrow interactions exist between these two systems and account for the influence of the terrestrial environment on the aquatic environment and vice versa. Such influences in the direction inland/water lie in the vegetable immigrant contributions. The difference with perennial rivers is the fact that ephemeral streams are less rich in particulate matter in downstream.

Ephemeral streams can be regarded to be dynamic with a structure, an operation and clean permeability. They can be characterised by biotic and abiotic descriptors. Moreover, these ephemeral streams must be considered at various scales of time and space in relation to the dynamics of water.

The quantification of the vegetable contributions, which represents one of the principal sources of energy in the aquatic ecosystems, has been well studied in the permanent ecosystems. The trophic dependence of benthic fauna with regard to these contributions has also been largely discussed in the literature.

In water, the litter undergoes a series of modifications. Initially physical, they lead to a transformation, which is the work of the group of the bacterium and mushrooms. This is called the phenomenon of conditioning. Various heterotrophic organisations (Chain of the detritivorous) reinforce and supplement this action. A series of observation in the System Zegzel-Cherraa (Maamri and al 1996, 1997) enabled us to

release the importance of the detritivorous in this mechanism. Indeed, to reach this trophic resource, the aquatic invertebrates depend on the intervention of the microorganisms (particularly mushrooms) which presence influence in a very decisive way the qualities of the layers and make them gravitational for benthic fauna. Indeed, once conditioned, the vegetable material is used by the aquatic animals as sources of food. A non-comparable part of these refuses are re-introduced into the medium in the form of excrements to be colonised again by the microorganisms and to be consumed then by **the coprophage organisms**. Moreover particles resulting from the mechanical fragmentation and/or biological enter the stock of the Fine Organic Matter Particles (MOPF < 1mm) and constitute thereafter a new source of food for **the collecting invertebrates**.

The biological system thus aims on one hand to the effective use of the contributions of energy by sharing the resources (food, substrate... etc) and on the other to an opposed tendency towards a uniform rate of conversion energy during the year according to VANNOTE and al. (1980). The structural and functional characteristics of the aquatic communities are adapted in order to conform to the average conditions, which are most favourable for them in the physical system. The characteristics of the producers and consumers communities inhabiting a given segment of the watercourse put themselves in harmony with the physical and dynamic conditions of the channel and its banks. These communities form a temporal continuum of synchronised replacement of species. Thanks to this continuous replacement, there is a distribution in the time and the space of the use of the energy contributions by the aquatic macrofauna. The example of the Zegzel-Cherraa system illustrates well this phenomenon. Indeed, in this ephemeral stream, Maamri et al. (1996 and 1997) noted a clear predominance of the dilacerators upstream in the upper section of Zegzel, where the bordering vegetation is dense and the contributions are coarse dominate and a high density of the collectors downstream in Low Zegzel, site characterised by the poverty of its vegetable cover but by the predominance of the fine particulate organic Matter (MOPF). In the often dry Cherraa stream the problem is much more complex. The degradation of the vegetable matter is prone to two distinct phases: an aquatic phase and a terrestrial phase. During the terrestrial phase, mushrooms and ground microfauna begin the phenomenon of degradation then the particulate organic matter joined the river by air or water undergoing the continuation of the phenomenon of degradation. In this aquatic phase collectors activities begin.

II. Comparison between Biotic Components of Perennial River and ephemeral stream

The Moulouya as example of Mediterranean Perennial River under semi arid climate, the existence of ephemeral streams in this Mediterranean region is related mainly to precipitation and with the karstic nature of under ground the course is permanent only in the upstream reach. The feature dominating the ephemeral stream is thus the irregularity of its flow. The flooding, the low water levels, the diversion for the agricultural irrigation, the dryness, the aridity of the climate, the collecting of the sources and the infiltration are the major hydrological events to which is subjected this typical ephemeral stream in this Mediterranean area.

The whole course of ephemeral system is temporary due to small reserves in the aquifers, to the soil impermeability and to the semi-arid climate. Flow duration is directly linked to rainfall. It generally extends to over late autumn, winter, and a part of spring or even summer. The gradual decrease in discharge results in slower flow

velocities and smaller submerged areas together with an increase in temperature up to 28-32° C in early summer.

In this study case, both ephemeral streams and perennial rivers, we can note:

- the presence of species belonging to the paleartic zone with endemic species
- the predominance of the thermophilous species
- Absence of the Plecoptera. This seems related to the high temperatures in summer.
- Discontinuity concerning the trophic groups related to hydraulic installations stopping the upstream downstream gradient. This is very characteristic of rivers in the south of the Mediterranean basin.
- In general, the studies of longitudinal distribution of benthic macro invertebrates show that the Ephemeral stream does not correspond to prediction of the River Continuum Concept (Berrahou. 2001). The comparative study of the longitudinal distribution of benthic macro invertebrates to perennial ones as Moulouya river shows that taxonomic and species richness (mainly Mollusca, Ephemeroptera, Plecoptera , Coleoptera and Trichoptera) showed similar patterns with a maximum downstream. Biotypologic analysis distinguished four sections:
 - I. The upper, including springs and mountain tributaries with crenobial-rithral species,
 - II. A transitional zone
 - III. The very homogeneous section of the middle Moulouya plus downstream zones of tributaries characterised by eurytopic-thermophilous species,
 - IV. The lower Moulouya characterised by potamic-limnophilous species downstream from two successive impoundments.

On this basis the study of functional feeding groups showed that only the lower Moulouya (Perennial River) did not correspond to the prediction of the River Continuum Concept. The discontinuity the lowermost section was due to both regulation effects (discharge and streambed with reductions) and to more abundant riparian vegetation.

The perennial river is characterised in general by high specific diversity of aquatic Coleoptera than ephemeral streams:

- The upper of south Mediterranean perennial rivers are characterised by the presence of stenothermal species as *Gammarus gauthieri* and *Beatis rhodani* which is regarded as cold stenothermal in the south of Mediterranean. A Sector with abundant vegetation where one finds the majority of shredders.
- In the middle of south Mediterranean perennial river and down stream zones of principals tributaries, we can found Ephemeroptera, Coleoptera and thermophilous Trichoptera or potamic Trichoptera as (*Ceanis luctuosa*, *Beatis pavidus* and *Hydropsyche maroccana*): We found of the majority of grazers in a broader and less shaded sector and collectors in the polluted sectors with a very degraded vegetation.
- In the lower of south Mediterranean Perennial River, we found a high macro-invertebrates diversity with many potamophilous species as (*Atyaephyra dermasteii*, *psychomyia pusilla*, *Mystacides azurera*) or typically limnophilous as Mollusca Molanoidae. The presence of impoundments often stops the upstream downstream gradient. Generally one finds in this sector a predominance of the grazers and a considerable presence of shredders and collectors.

The downstream of the south Mediterranean perennial river is defined as an independent sector of the river from the functional point of view. This is related to the combination of the effects of the human activities and actions (regularisation of the flows by pumping with the bed reduced to half) and of a natural situation as for the resources (aquatic plants and riparian vegetation having colonised the major bed of the river) compared to the upstream.

The biotic components of the ephemeral streams (fauna and flora) and their organisation are related to the conditions of the environment (current velocity, temperature of water, riparian vegetation, chemical characteristics, human impacts etc...). In this paper we see three sections which describe the major characteristics of the different types of ephemeral rivers, that is:

- Ephemeral stream that flows all the year round but sporadically dries out, seems to have the best balances structure of its communities. The disturbance of the structure took place at the rising but the biotic recolonisation is fast in few days.
- Ephemeral stream that dries every year during a specific period of time with low environment flow has a very fragile structure. This is related mainly to the water pumping and the water deviation to irrigated cropping.
- Ephemeral stream that it is always dry but has a flow every now and then, lodge the most resistant communities the least diversified.
- Generally more abundant riparian vegetation is an important factor for the maintenance of the life in Ephemeral streams.
- The recolonisation of this zone after the rising is ensured by the invertebrates remaining on the spot in the zones of refuge and from the contributions by the aquatic or air way. It is related on the seasonal factors and the normal biological cycle of the species constituting the settlement.
- In general, the studies of longitudinal distribution of benthic macro invertebrates in Ephemeral stream not correspond to prediction of the River Continuum Concept as the lower of perennial rivers where impoundments are implanted.
- In ephemeral streams floods recharge the groundwater systems of banks and erode the bed of the stream to maintain its stability and its structure. The rising ensure a varied ecological process in the ephemeral stream such as:
 - the spawning of fish,
 - the transport of eggs of insects,
 - germination of bank seeds and explosive increase of many animal and vegetable species,
 - distribution of seeds
 - redistribution of the micro-organisms

D-Ecosystem services and reasons for importance of Mediterranean ephemeral streams

Main services

The functioning of natural ecosystems provide “services” that are essential for human health and survival. The concept of ecosystem services is seen as one way to address these issues. Instead of asking what do we have to give up in order to have a healthy environment; we ask the question, what do we have to gain by maintaining ecosystem function? This includes asking who benefits from the delivery of ecosystem services? and how can costs and benefits be fairly shared?

The concept of ‘services’ arose to acknowledge the reliance of people on ecosystems. Ecosystems perform functions that allow humans to live on earth and fulfill their lives in a variety of ways. People are important in the delivery of ecosystem services too. People like farmers manage ecosystems and hence play a key role in sustaining and fulfilling human life. In the past, the role of land managers in providing food was recognised, but this is now expanding so that their roles in maintaining air and water quality, climate, flood protection, healthy rivers, pest control, pollination, biodiversity, and cultural, spiritual and intellectual values is also being recognised.

Which ecosystem services are in play in Ephemeral streams ?

Mediterranean continental water studies have shown that declining ecosystems are affecting people in terms of their supplies of food and water, living conditions, and physical and mental health. This provides a basis for describing the consequences of ecosystem change in terms that mean something to all consumers and addresses the big question who benefits from these services and how costs and benefits can be fairly shared, and provides a basis for developing incentives, including new markets, to encourage investment in natural resource management that has greater overall benefit for communities and society generally. The general public is often overlooked as the biggest group of consumers whose opinions and attitudes influence the value placed on the environment in decision making. Yet, to date, there have been few cases where they have been engaged in discussions about the value of ecosystems, this is because it has usually been carried out in technical language and concepts. All society needs to be involved in asking when and how in the management of natural resources linked to ephemeral streams and the benefits they might bring for them such as:

Production of goods

Food: Terrestrial animal and plant products, forage: Ephemeral ecosystems are very productive. The local population lives mainly of the production of the riparian vegetation and stream.

Pharmaceuticals: Medicines, precursors to synthetic drugs: Among the riparian vegetation, one finds many medicinal and/or aromatic plants as *Mentha – Rosmarinus* etc. to use for traditional medicine or pharmaceutical or cosmetic industry.

Durable materials: Natural fiber, timber: Ephemeral streams in a mountainous forest are very productive. Mediterranean forests are often traversed by ephemeral streams

Genetic resources: The basis for the production of other goods as conservation of biodiversity for many plants, animals and migratory birds that use ephemeral streams as points of fall or seasonal sites.

Regeneration processes

Cycling and filtration processes: Detoxification and decomposition of wastes, renewal of soil fertility, purification of air and water: maintains humidity of the ground and bank stabilization.

Translocation processes: Dispersal of seeds necessary for revegetation, pollination of crops and native vegetation. Deposit of the nutritive substances on the banks and the wetlands.

Stabilising processes

Ephemeral streams have an ecological flow for to maintain the functioning of biodiversity and ecosystem. They have capacity to control :

- Ephemeral stream stability,
- compensation and substitution of one species for another when environments vary,
- control of the majority of potential pest species,
- moderation of weather extremes (such as temperature and wind),
- Regulation of the hydrological cycle (mitigation of floods, droughts, salinity etc...)

Life-fulfilling functions from ephemeral streams

Aesthetic beauty, cultural, intellectual, and spiritual inspiration, existence value and the greatness of God for religious people, scientific discovery, serenity etc.... One can take photographs of nature and landscape and observe birds.

Why are healthy ephemeral streams important?

Healthy waterways with good water quality have multiple benefits for water and riparian fauna and flora communities and for human beings. The ecosystem services provided by healthy waterways can be described under the following headings:

Agriculture

The transport of water from upper catchments to irrigated cropping and its temporary storage in temporary pools, is a major ecosystem service provided by ephemeral stream. Without these natural waterways, artificial canals must be built to transfer water from one point on the landscape to another. The use of ephemeral stream as an artificial channel is linked to an environmental cost. Downstream flow patterns are often dramatically altered in many rivers and can have dire consequences for in-stream biota. These engineering changes are of great benefit to the agriculture, they present a threat to other ecosystem services provided by waterways.

Drinking water

As well as transporting and storing water for potable use, natural, healthy waterways provide an important service in improving the quality of drinking water. In turn, this reduces the cost of treating the water prior to human consumption. For example, human bacterial and protozoan pathogens (natural and human) from catchments may be removed during their passage downstream in rivers (self depuration phenomenon), or can be consumed by natural predators that live in water. Natural organic matter found in catchment rainfall run-off is also degraded and metabolized by river biota. This service is provided by ephemeral streams and perennial rivers.

Recreational fishing

Fishing is not a popular past time in ephemeral streams in Morocco. Healthy ephemeral streams support populations of native fish species that are rarely sought after by anglers. Supporting sustainable stocks of native, and sometimes introduced local species (e.g. *Barbus marocanus*), is a highly desirable service provided by ephemeral streams. Aquaculture activities in ephemeral streams seem to be very difficult.

Other recreational uses and aesthetics

The use of ephemeral streams for recreation and eco-tourism is another important service. These activities include swimming, camping and canoeing. The general aesthetic value of a healthy ephemeral stream, its riparian trees and the beauty of the terrace cultivation. In the case of the upper of Zegzel, one can underline the role of the “grotte de pigeon” like prehistoric inheritance of humanity.

Box 4 - Main services in the Mediterranean Ephemeral Stream and Reasons for its importance

Main services

- I. Use of water by the local population and especially the farmers
- II. fixing of the population (rural migration)
- III. tourist attraction
- IV. refill of the ground water
- V. Extraction of sands and gravels for construction ad building
- VI. Production of goods
- VII. Regeneration processes
- VIII. Stabilising processes
- IX. Life-fulfilling functions

Reasons for its importance

- Agriculture (aquatic resource for agriculture under arid climate)
- Drinking water a source of water for local population and cattle all through the basin.
- Recreational fishing
- Domestic requirements out of water for local population that particularly rely on river flows
- creation of many jobs in agriculture and ecotourism etc...

e- Critical situations

The destruction of Mediterranean ephemeral streams is alarming. Most rivers have been partly diverted and/or regulated. A great number of springs has been impounded and canalised, and aquifers are intensely exploited. Most cities are located near rivers or springs, and their wastes contaminate these environments.

It is also important to stress the recent appearance of temporary streams by modification of the perennial rivers, turning consequently into a desert and a dryness. This unwanted result is extending, more and more in the Mediterranean area, mainly due to overexploitation. Indeed, the increase in population, the phenomenon of urbanisation and the rise in the standard of living have increased the domestic and agricultural requirements of water; and they have considerably modified the modes of surface and underground waters. Thus, the abstraction of water from the sources and using the irrigation channels disturb the flows and limit the possibilities of food of the ground water.

One of the most dramatic consequences is the decline of fish population and invertebrate biodiversity. The Ephemeral streams suffer from the low flow periods due to crop irrigation. Spring harnessing has caused the disappearance of many local species.

f- Disposition and measurements

Ideally, the provision for environmental flows ecosystem should be supported by a comprehensive package of basin-wide management practises and regulations related to land-use, water rights, river banks, riparian vegetation, wetlands etc...

Several organisations are concerned with freshwater in various ways. Programming and carrying out research projects, monitoring and managing Ephemeral streams environment comes under the responsibility of organisms as:

- The Basin Agency
- The Office for Agricultural Development that comes generally under the Ministry of Agriculture and rural development.
- The Office for Water and Forestry
- Ministry of Environment
- Ministry of tourism
- Ministry of Higher education and scientific research.
- Local authorities and elected representatives of population.
- The local NGO (s)

The management of ephemeral stream encounters probably some difficulties owing to the fact that it is ensured by several government department and partnerships. The principal measurements to be set up in Ephemeral streams are:

- the protection and the optimisation of the use of the water resources;
- the protection and the valorisation of the wetlands ;
- the minimisation of the negative impacts on the stream ;
- the rational management and regulation of the flows ;
- the restoration of the wetlands and the degraded ecosystems.

Multidisciplinarity action is an effective means to obtain better results with the condition of involving the commitment of each partner under a river contract.

Capacities need to be built amongst various actors to design and implement environmental flows in Ephemeral streams. The training of lowers, decision makers, technical staff, NGO members and policy makers may therefore be necessary. It is also important to empower and educate politicians on societal costs of managing ephemeral streams by:

- training courses;
- defining an assessment framework;
- application of methods;
- visits to case study sites to learn the enlightened practices and to avoid the errors in decision;
- technical workshop and symposiums;
- Production of technical support.

Box 5- Critical situations

- In this ephemeral stream, Use of water by the local population and especially the farmers (hydrological disturbance) to link to desertification, increase urbanisation and demographics;
- Use of the pesticides and fertilisers from upstream population, related to the modern agriculture; This is supposed to be the main cause of fish mortality.
- We note increasing pressure of the tourists and the Sunday strollers: massive and frequent presence: lucrative and educational tourist activities;
- lack of sites arranged for the picnics and the places of camping;
- waste release in the stream and its resurgences and harmful impact on aquatic fauna and loss of the biodiversity;
- Release of detergents from car, clothes and wool washing in the bed or next to it.
- Pressure of Cattle: sources of non-point source pollution and destruction of the riverine vegetation. It would be also the consequence of the strong reduction of the birds nests.
- Presence of an urban centre downstream on the level of the Cherraa stream (town of Berkane a city into full growth): discharge of waste water;
- flooding force devastator;

g-The main biotic disciplines involved in EFAs in ephemeral rivers.

Environmental flows require the integration of a range of disciplines, including engineering, law, ecology, economy, hydrology, political sciences and communication. It also requires negotiation between managers, scientists, engineers, population, policy makers and local authorities.

The manager plays a vital role by bringing these specialists together and helping forge a common language. The main abiotic and biotic disciplines involved in EFAs are:

- Hydrology and Meteorology: to determine the flow and the water run-off under climate change to show also the role of water as vital for maintaining of the life in the ecosystems of ephemeral streams.
- Ecology and Hydrobiology: to determine water quality, microbiology, ecological aspects of ecosystems, ecosystem functioning and biodiversity.
- Geology: Hydrogeology and sedimentology: the geological nature of the ground and the nature of the substrate determine the habitat of fauna and flora and the ecosystem functioning.
- Agronomy: the Ephemeral stream is partly diverted and/or regulated. A great number of springs have been impounded and canalised, and aquifers are intensely exploited. A rational management of the agricultural irrigation in these fragile areas is more than essential.
- Sociology and Anthropology: most cities are located near rivers or springs, and their wastes contaminate this hydrosystem. It's very important to know the domestic requirements out of water for local population and their behaviour to evaluate the impact of EFAs on ecosystems.
- Economy: development of economics resource and building capacity among resource economists while keeping the ecological balance of these fragile ecosystems.

- Environmental law: knowledge of ephemeral stream and reinforcement of the legal framework: In the case of Morocco the management of wetlands encounters difficulties due to the fact several government departments have competences in this field.
- Ecotourism: increasing pressure of the tourists, Sunday strollers, sources of pollution and destruction of water ecosystems and the revering vegetation.

h- Provisions as regards the ecosystem and associate social-culture and livelihood dimensions

Ephemeral streams generate many benefits for population. So, it's important to define Water requirements and water allocations to know how the population uses water under various flow conditions. In Mediterranean region, water is generally a public property, which also generates many problems between users. In certain cases problems, the residents call upon a wise person generally a religious head such as the imam of the mosque to regulate the conflicts.

The preservation of the ecosystems in ephemeral streams requires also the implication of the local elected persons of the population and the Parliament representative of the area which must play the role of interlocutors with the administration, to make arrive the water needs, to improve the use of water and the resources of the ecosystem and to defend the population.

All River Basin Organisations in the Mediterranean must develop a particular attention to Ephemeral stream (Group of follow-up and control of Ephemeral streams) who must program and carry out research projects, monitoring and managing Ephemeral streams ecosystems in all continental aquatic environment without underestimating the concept of EFAs (Dyson and al. 2003). It will be charged with the task to formulate the general orientations of the Ephemeral streams policy.

i- Horizons and priorities

i-Research

Compared with the studies made in the permanent aquatic places, work in the Ephemeral streams is still far from advanced. It's very important to develop:

- research of ephemeral streams as a whole (environment/population system);
- a national database on Ephemeral streams, networking and communications;
- hydro agricultural impact studies;
- native impact of pollution on the ephemeral streams
- studies of social impacts on subsistence users

The actual research done in this field in Morocco is Hydrobiology , HydroEcology and Hydrology but the main studies done in ephemeral streams are Ecological functioning.

ii-Adaptation of Tools and Methods

- Developing the transfer of technology;
- valorisation of traditional technology;
- reinforcing the legal framework (e.g. like the Moroccan law 10–95)
- to create a Mediterranean network on ephemeral streams;
- to seek a financial support;
- planning actions to be carried out in dialogue with local population ;
- to set up station weather stations in the basin of Zegzel and all the basin of Moulouya;
- to manage the irrigation by using of economical techniques as drip irrigation
- Increase local population participation:
 - by encouraging them to be involved in sustainable development projects;
 - by informing them about rational use of the natural resources
 - by sensitising local population around the stream
- developing planning by objective

Box6- Water law N° 10-95 N° 10-95 in Morocco

To reinforce the existing institutional framework as regards management of water, the law on Water N° 10-95 A creates agencies of basins, publicly-owned establishments, equipped with the legal entity and financial autonomy. They have the role of evaluating, of planning and of managing the water resources on the level of the hydraulic basins.

iii-Partnerships

- The Basin Agency
- The Office of Water and Forest.
- Ministry of the Environment.
- Ministry of Tourism.
- Researchers from University
- Local authorities and elected persons
- Local NGO (s)
- Regional and international cooperation

iv-Demonstrations or Application

- Development of the ecotourism and valorisation of the local production of Ephemeral streams
- Development of an environmental program of education intended to the schoolboys and for general public in partnership with of Local NGO (s): educational circuits - center of protection and sensitising to the environment around Ephemeral streams
- Management of the agricultural irrigation according to the flows.
- Planification of the actions to be carried out in dialogue with local populations .
- Valorisation of ecological sites
- Reinforcement of the legal framework
- To respect engagements towards the RAMSAR Convention.

In the case of this study, we propose the following recommendations for the Ephemeral streams:

It is prohibited:

- 1 - to anticipate constructions, on the limits of the freeboards of the temporary rivers, irrigation channels, belonging to hydraulic public domain;
- 2 - to place within the limits of the hydraulic public domain all obstacles blocking the free water run-off and freedom of movement on freeboards;
- 3 - to throw in the bed of the rivers some objects likely to embarrass this bed or y to cause alluvial deposits;
- 4 - to cross the irrigation channels, or drains with open sky include in the hydraulic public domain, with vehicles or animals. Points where herds will be able exceptionally to reach are fixed by the agency of basin.
- 5- It is prohibited, except preliminary authorisation delivered according to methods fixed by lawful way:
 - to carry out or remove any deposit, any plantation or crop in the field hydraulic public,
 - to clean, look further into, widen, rectify or regularise the stream,
 - to carry out building material extractions, in the beds of the ephemeral streams.

General conclusions

Like the majority of the Mediterranean ephemeral streams, the Zegzel-Cherraa system is characterised by the irregularity of its flow and brutal hydrological demonstration. The annual mode, closely related to the rainfall, is marked by rising in autumn until spring and by a severe low water level of summer. It is a river located in a zone envisaged like a protected areas in the south of Mediterranean where the UICN attaches a great importance for integrated management of this protected areas in the Mediterranean (Lopez & Correas, 2003). The biotic components of the systems (fauna and flora) deal

with the temperature, evaporation and human disturbance and water fluctuation. They adapted to this. The adaptation is morphological, ecophysiological and genetic. One attends an Co-evolution of the species of the ephemeral stream with their ecosystem and general area.

Key messages

- Ephemeral streams are very important and generate benefits for people and nature: Environmental flows provide critical contributions to river health, economic development and poverty alleviation.
- The river and drainage system should be considered in its context from the upper to the lower system including its wetlands, floodplains and associated groundwater systems.
- Development of the legal framework and policy is more necessary because the management of ephemeral streams in Morocco encounters difficulties owing to the fact that it is ensured by several government departments.
- The Agency of Basin should not underestimate environmental flows and ecological aspects of stream and should encourage the public participation process.
- Communications and the media are vital elements for making progress, sustainable development and the long-term-prosperity of communities.
- Training capacity among scientists, engineers and resource economists.
- Eradicating illiteracy one of the causes of under development and irrational practices of use of water in the countries of the South of the Mediterranean.

INDICATORS DRIVERS OF THE BIOTIC ASPECTS IN EPHEMERAL STREAM

Environmental Flow: current velocity Rising	- flow duration is directly linked to rainfall redistribution of the micro-organisms - distribution of seeds - germination of bank seeds and explosive increase of many animal and vegetable species, - the transport of eggs of insects, - the spawning of fish - ecological process : Birth-rate, mortality, emigration and migration
Zones of refuge	Maintain the life of fauna in the event of rising
Temperature	the dryness, the aridity of the climate: adaptation of biota: eurythermal species
Water quality	Maintain the biological quality of stream
Irrigation	Discontinuity concerning the trophic groups related to hydraulic installations stopping the upstream downstream gradient.
Pollution	Negative impact on biota
Gravel extraction	Destruction of macro-invertebrates habitat
Cattle's	Trampling of riparian vegetation
Eutrophication	Invasion of mosquitoes and the undesirable odours
Derivation of water riparian vegetation	Disappearance or migration of fauna a more abundant riparian vegetation is an important factor for the maintenance of the life in Ephemeral streams (supply of organic matter)
Organic matter	Trophic resources for fauna

Comparison between Biotic Components of perennial river and ephemeral stream

Ephemeral stream	perennial rivers
<p>The major characteristics of the different types of ephemeral streams are:</p> <ul style="list-style-type: none"> - Ephemeral stream that flows all the year round but sporadically dries out, seems to have the best balances structure of its communities. The disturbance of the structure took place at the rising but the biotic recolonisation is fast in few days. The upper section Ephemeral stream is caricaturised by abundant vegetation where one finds the majority of shredders. - Ephemeral stream that dries every year during a specific period of time with low environment flow has a very fragile structure. This is related mainly to the water pumping and the water deviation to irrigated cropping. – In the middle section of Ephemeral streams the majority of fauna are grazers (Ephemeroptera, Coleoptera and thermophilous Trichoptera or potamic Trichoptera as (<i>Ceanis luctuosa</i>, <i>Beatis pavidus</i> and <i>Hydropsyche maroccana</i>) and collectors in the polluted sectors. - Ephemeral stream that it is always dry but has a flow every now and then, lodge the most resistant communities the least diversified. – In the lower section of Ephemeral streams the majority of fauna are potamophilous species as (<i>Atyaephyra dermati</i>, <i>psychomyia pusilla</i>, <i>Mystacides azurera</i>) or typically limnophilous as Mollusca Molanoidae. 	<p>In general Mediterranean perennial rivers are subdivided in three sections:</p> <ul style="list-style-type: none"> - The upper of south Mediterranean perennial rivers are characterised by the presence of stenothermal species like <i>Gammarus gauthieri</i> and <i>Beatis rhodani</i> which is regarded as cold stenothermal in the south of Mediterranean. A Sector with abundant vegetation where one finds the majority of shredders. - In the middle of south Mediterranean perennial river and down stream zones of principals tributaries, we can found Ephemeroptera, Coleoptera and thermophilous Trichoptera or potamic Trichoptera as (<i>Ceanis luctuosa</i>, <i>Beatis pavidus</i> and <i>Hydropsyche maroccana</i>): We found of the majority of grazers in a broader and less shaded sector and collectors in the polluted sectors with a very degraded vegetation. - In the lower of south Mediterranean perennial river, we found a high macro-invertebrates diversity with many potamophilous species as (<i>Atyaephyra dermati</i>, <i>psychomyia pusilla</i>, <i>Mystacides azurera</i>) or typically limnophilous as Mollusca Molanoidae. the presence of impoundments often stops the upstream downstream gradient. Generally one finds in this sector a predominance of the grazers and a considerable presence of shredders and collectors.
the predominance of the thermophilous species	Predominance of the thermophilous species only in the middle and lower river.
Irregularity of its flow and brutal hydrological demonstration.	Seasonal flooding depending to the climate
Instability of habitat	Stability of habitat
Collecting of the sources and the infiltration	Collecting of the sources and the infiltration
Presence of species belonging to the palearctic zone with endemic species	Presence of species belonging to the palearctic zone with endemic species
Taxonomic and species richness (mainly Mollusca, Ephemeroptera, Plecoptera , Coleoptera and Trichoptera) is important in the upper stream	Taxonomic and species richness (mainly Mollusca, Ephemeroptera, Plecoptera , Coleoptera and Trichoptera) showed similar patterns with a maximum downstream.
Absence of the Plecoptera: due to the high temperatures in summer	Presence of the Plecoptera in the upper due to the fresh temperatures in summer (High mountain)
Biotypologic analysis show that Longitudinal distribution of benthic macro invertebrates does	The study of functional feeding groups showed that only the lower of perennial river did not

not correspond to prediction of the River Continuum Concept	correspond to the prediction of the River Continuum Concept.
High specific diversity of aquatic Coleoptera	Low specific diversity of aquatic Coleoptera
Diversion for the agricultural irrigation,	Presence of impoundments and water pumping often stops the upstream downstream gradient
Ecosystem services are vital for local population - The adaptation of fauna and flora is morphological, ecophysiological and genetic. One attends an Co-evolution of the species of the ephemeral stream with their ecosystem and general area.	Ecosystem services are much more numerous - The adaptation of fauna and flora is related to the sector of perennial river and general climate

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Most papers cited here were written in French or arabic. Perhaps because the mother tongue of Moroccan scientists is Arabic, their first foreign language is French and English is a third language from them that most of them can read but not write. Many references are theses or reports the results of which have not been published in scientific journals.

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