

URBAN FLOOD MANAGEMENT IN CYPRUS – CASE STUDY IN NICOSIA URBAN AREA

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Abstract

Cyprus is experiencing negative impacts from flooding due to rainstorms in its urban environment. There are no official figures on the extent of urban flood damage. However, the information from insurance companies is that, although Cyprus lies in a seismic region and its climate is semi-arid, the extent of the urban flood damage is more than the extent of earthquake damage. Main causes of damage are:

- the lack of storm water drainage systems
- the disruption of pre-existing natural watercourses by urbanisation
- the blockage of man-made watercourses
- the ever-changing land use

Main effects/ impacts of damage are:

- flooding of basements and low lying floors: damage to parked cars, central heating systems, goods stored
- consequential damage: loss of productive time, loss of guarantees/ warranties of electrical/ mechanical equipment

This paper presents an institutional analysis, highlighting the gaps in planning, implementation, maintenance of urban flood management systems. It includes a case study of flooding caused due to institutional gaps and proposes measures to reduce the risk of urban flood damage.

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Introduction

Cyprus is the third largest island in the Mediterranean Sea, with an area of 9.251 km².

The most significant geomorphologic features are:

- the Troodos mountains, having peak elevation of 1.950m, on the south-west of the island,
- the longitudinal Pentadaktylos/ Kyrenia mountain-range, with peak elevation of 1.000m, on the north part and
- the Mesaoria plain which lies in-between the two mountain ranges. Forests, of mainly pine trees, cover about 1/5th of the total area of Cyprus.

The climate is semi-arid, with mild and relatively wet winters and hot, dry summers. Rainfall is variable having a mean intensity of the order of 500 mm per year. Continuous droughts are becoming more frequent, whilst in the last 30 years the mean rainfall has been reduced.

The location plan of the island and the special distribution of the average annual rainfall are presented in figure 1.

All rivers are seasonal rivers, which flow only after rain storms.

The population of the island, in the areas under the control of the Republic of Cyprus (37% of the island, on the north part of the island, is under Turkish occupation) is about 750 thousand people, of which about two thirds (2/3) live in urban areas. Urbanisation took place over a very short period of time, the urban population being doubled in just 30 years (1960 to 1990).

The water problem of Cyprus

Water shortage is a major problem. In order to address this problem, the Republic of Cyprus adopted the slogan “Not a drop of water to be wasted to the sea”. A series of dams has been constructed in recent years, and today almost all (seasonal) rivers are dammed. The rivers and the dams of Cyprus are shown on map on figure 2.

Cyprus has the largest number of dams per area in Europe.

The development and management of the water resources and of the dams is performed by the Water Development Department (WDD) of the Ministry of Agriculture, Natural Resources and the Environment.

Since the rivers that are dammed are seasonal ones, the dams are usually not full. Their primary role is to store water. The use of water is carefully managed and

monitored. In exceptional cases some dams experienced overflow in the past, which however was controlled.

The function and operation of the dams is such that they also perform as flood prevention structures. No flooding problems of the rivers downstream of the dams have been experienced.

However, in urban areas, whose catchment area is independent from the dam related catchment area, flooding problems are frequent.

Institutional Analysis

There is generally great fragmentation regarding the jurisdiction and responsibilities for managing the drainage of storm water. The responsibilities of various Public bodies, summarised in table 1, are presented and discussed below.

Water Development Department, Ministry of Agriculture, Natural Resources and the Environment

As mentioned above, the Water Development Department is responsible for the development, planning, implementation and maintenance of the water resources. Its jurisdiction covers the rivers, wells, boreholes, springs, ground water and other natural resources. It does not include the drainage of urban areas which is not associated with natural streams/ rivers/ water courses.

The dams, which fall under this Department's jurisdiction, are effective flood defences when there is adequate storage capacity. The responsibility of the Water Development Department is to take measures to alleviate the water shortage problem of the island. The fact that in the past the dams were not full when there was intensive rainfall and the dams performed as effective flood control measures does not necessarily imply that this will always be the case.

There is no official policy to closely monitor the weather forecasts and lower the level of water stored in the dams when there is a risk of flooding.

Local Authorities (Municipalities)

The Municipalities Law allocates jurisdiction to Municipalities to *construct, maintain and operate storm water drainage systems* within the Municipal boundaries, in cases where there is no Sewerage Authority with jurisdiction on the storm drainage.

This law has the following limitations:

- it does not impose responsibilities to Municipalities to co-operate with other Municipalities associated with the same drainage path/ catchment area
- it allocates more power to the Municipalities than they need and it does not require the Municipalities to acquire permission from a higher Authority / central Government Department prior to the construction of drainage works

Community Councils/ Ministry of Interior (District Officer)

In areas other than Municipal areas, the jurisdiction regarding storm water drainage lies with the Community Councils. The Community Councils are co-ordinated by the Ministry of the Interior, through the District Officer's office. This second tier of co-ordination has a most beneficial effect on storm drainage systems, since it enables the integrated management of the flooding problem.

Department of Town Planning and Housing, Ministry of Interior

The Department of Town Planning and Housing (TPH) is the competent Authority for Urban Planning. Urban planning takes into consideration:

- land use,
- building density,
- road traffic,
- amenities,
- green areas
- and many other parameters

in developing, implementing and managing urban development plans.

However, urban storm water drainage is not included in the responsibilities/ jurisdiction of this Government Department. As a result, no provision is made when preparing town plans to ensure continuous, smooth and adequate storm water drainage routes.

Some works which benefit the community at large (not only the Municipality itself) are classified as "Town planning schemes" and get partial funding from the Department of Town Planning and Housing. Urban storm drainage works have been classed as "Town planning schemes" and received funding from Central Government through this Department. However, this funding is not treated as a form of licence nor subject to terms or conditions regarding the performance and effectiveness of the schemes.

Public Works Department, Ministry of Communications and Works

The Public Works Department (PWD), is responsible for the planning, construction and maintenance of Public Works, mainly in the Transport sector. It is the policy of the PWD to address storm water drainage associated with individual road schemes that fall under its own jurisdiction. Generally, apart from a small number of urban roads (which form part of the main road network) the PWD is not involved with urban storm water drainage.

Ministry of Commerce, Industry and Tourism

The Ministry of Commerce, Industry and Tourism is the Government body responsible for the management of industrial areas, usually in the outskirts of urban areas and occasionally inside urban areas.

Storm water drainage is taken into consideration in the development of the plans of the industrial areas, but only within the boundaries of the industrial area. Its jurisdiction does not extend to cover the whole catchment area.

This Government body has therefore a most fragmented jurisdiction.

Sewerage Boards

Sewerage Boards are being gradually formed in the major urban areas. Their primary objective is the planning, construction, maintenance and operation of sewerage systems. In some Sewerage Boards, their jurisdiction is extended to include storm water drainage systems as well. The boundaries of the jurisdiction of the Sewerage Boards are larger than those of Municipalities.

These Boards are the most appropriate to manage urban storm water drainage. Their jurisdiction should be extended so that they contribute and influence the development of Urban Development Plans so that most flooding problems are addressed at their root.

Lands and Surveys Department, Ministry of Interior

The Lands and Surveys Department has a comprehensive set of maps of the island. The topographic maps reproduce on paper the topography at the time of the survey. As the rivers in Cyprus are dry ones, in areas where the route of the water course is over hard ground, like rock, and the river bed is not well formed, no river is shown on maps. The phenomenon of having maps showing discontinuous rivers is very common and frequent.

In all cases where rivers are shown on land property, the landlord has to respect the right of way of the storm surface water flow. In the cases however, where the river path is discontinuous, the landowner of the property in the gap between the river has no obligation to allow the river flow. There is effectively then blockage of the water course.

The Lands and Surveys Department could and should identify all the cases where there are discontinuous rivers and mark on all maps, whether the storm water route leaves a print on ground or not, the water course.

Audit Service

The Government Audit Service carries out technical audits as well. It reports directly to the President of the Republic of Cyprus regarding the implementation by the various Government Departments and Public Bodies of State Laws and Procedures. If there is no violation of the law or procedures, no blame can be placed on the audited body.

An improvement of the Audit Service role could be:

- the analysis of losses suffered / expenditure of public funds due to natural phenomena and
- the reporting to the President recommendations for institutional changes where necessary

It is noted that the losses suffered by Municipalities and Public Bodies that are not Government Departments do not appear as losses since they are paid by Private Insurance companies and the Insurance premium is not directly related to particular events. Government Departments are self Insured.

Environment Service

The Environment Service, of the Ministry of Agriculture, Natural Resources and the Environment, is the Competent Authority which reports to the Government regarding the assessment of the impact on the Environment of storm water drainage works. The findings of the Environment Service are transposed into terms and conditions in the construction licences granted to various projects.

The Environment Service is progressively acquiring more power and its jurisdiction is extended. Presently however, the Environment Service is not independent. It falls under the Ministry of Agriculture, Natural Resources and the Environment and its role in evaluating and imposing terms and conditions on Government projects is not clear.

Civil Defence

A newly established body, the Civil Defence, is the Government Emergency Response Body. Its jurisdiction includes the response to damage caused by rain storms. No major flood damage has occurred since its establishment.

Case Study: Urban Watercourse in Nicosia

Problem Definition

A characteristic case study presented as a demonstration case is an urban watercourse in Nicosia. In this case, storm water flows from one Municipality upstream, into a neighbouring Municipality downstream. Prior to the urbanisation of the area, there was a natural seasonal river bed which was clearly marked on ground and hence on topographical maps. The drainage route was kept clear of constructions for the width marked on the maps. The river bed, being natural, did not have a constant width and its print on land had a variable width, ranging from 2 to 3 metres. In places the downstream width was narrower than the upstream width.

As far as the elevation and slope of the river bed and height of the sides of the natural channel are concerned, no such information is shown or specified on the Property Deeds maps. With progressive and sporadic urbanisation of properties (each urban development has a plot area of the order of 600 square metres) the seasonal river that was formed had a most irregular and uneven shape, with vertical walls right on the line marked on the maps as the edge of the river.

With progressive urbanisation:

- access to the river channel was becoming increasingly difficult and its maintenance almost impossible,
- vegetation growing on the boundaries and inside the channel was reducing the available capacity,

- the run-off from the building roofs, paved gardens, asphalt roads and concrete pavements was increasing and hence flooding problems to low-lying areas near the river route became a recurrent problem.

A particularly acute problem was experienced at road crossings where the open channel flow had to pass through a confined culvert. Bulky items carried by the river flow were stuck at the openings causing virtual blockage of the flow. Such bulky items found after rains storms include empty barrels, scrap refrigerators, mattresses and most commonly, tree branches and garden wastes.

Addressing the Problem

In order to address the urban flood problem the two neighbouring Municipalities co-operated and assigned the design of the urban drainage system of the main drainage channel to the same consultant. The design of the storm water drainage system took into consideration the whole catchment area up to the point of discharge into a main river.

The drainage channel, being in an urban area, having to pass under existing roads (whose elevation cannot change) and cross numerous Utilities' services (such as water supply and sewage pipes, buried electricity and telephone cables) had to be a closed conduit whose top elevation is some 0.6m below road elevation.

The designed channel is a reinforced concrete orthogonal/ box shape channel some 2m inside height and some 2.5 m wide. In order to support the neighbouring properties (mainly fences of back gardens and low level garages) the sides of the channel are extended as cantilevers up to about 20cm above the neighbouring ground level.

The project, mainly a storm drainage one also serves as a footpath, joining urban streets. The footpath has lighting and pavement furniture and also has purpose made access holes for the maintenance of the channel underneath the pavement. There are two types of accesses:

- circular metal covers (manholes) through which maintenance workers can enter and inspect the channel,
- reinforced concrete removable beams, through which mechanical equipment can be lowered and clean the channel.

The design was sent for comments to the Water Development Department, the Town Planning and Housing Department, the Public Works Department and the Public Utilities.

After taking into consideration the contributions of the above bodies, the tender documents for the construction of the works were prepared in such a way that each Municipality handles independently the works within its own boundaries.

The implementation of the project was to be carried out by each Municipality separately. The project, considered as a "town planning scheme", was to be mainly funded by central government funds (4/5) and partly by local government/

municipality funds (1/5). The funds were secured and the expenditure was included in the budget which is approved by Parliament.

Institutional Weakness

The Municipality upstream, which is the one experiencing recurring flood damage, went ahead in implementing its part of the works as proposed and approved by the various government bodies using the approved funds.

The Municipality downstream had problems with property rights in one location and its procedure was delayed. As a result, a dead-end channel was built which leads nowhere. The consequence of this action is that the flooding problem was shifted and concentrated to the dead-end of the new urban drainage channel. Figure 3 presents the dead-end storm drainage channel during construction stage, before and after a short duration storm.

Until the Municipality downstream joins the new drainage channel to the river, flooding around the dead-end area will be frequent, almost during each rainfall. Storm water fills up quickly the channel and the overflow is spreading to the low-lying areas.

Examining the role of each of the Institutions described above:

- Water Development Department: This Department had no involvement in the execution of the works. It only had advisory role during design stage on technical matters
- Department of Town Planning and Housing: This Department is funding 4/5 of the cost of the project. It did not have any role in determining the sequence of execution of the works.
- Public Works Department, Sewerage Board, Lands and Surveys Department: These bodies had no role in the implementation of the project.
- Audit Service: This Independent Body could not identify any wrong-doing prior to the initiation of the works. Even after the experience of flooding damage, the Audit Service is not informed of the extent of the damage since the cost is not shown in the State Accounts.
- Environment Service: This Body assessed the impact of the works and approved the implementation of the storm drainage channel. At that stage there was no intention to construct only the upstream part of the works and therefore the impact of this scenario was not assessed. The Environment Service does not have the means to monitor if the public works approved are implemented as presented to it.

In conclusion, although there is a large number of Public Institutions which are associated with urban flood systems, there are serious institutional gaps and the hazard of flood damage can and does occur.

Measures to reduce the risk of flood damage

Since the hazard of flooding is real and known, the vulnerability and the value of the items flooded needs to be minimised, so that the risk / cost of damage is minimum. The measures that need to be taken include the following:

- identification of the flood risk area/ areas
- public awareness/ informing the people living in these areas of the risks
- avoiding excavations and building basements in the flood risk areas
- avoiding the placement/ storage of goods sensitive to water in the flood risk areas (such as electrical/ electronic goods, paper products etc)
- monitoring the weather forecasts, informing the public and relocating any vehicles parked in the flood risk area prior to the rainfall
- diverting the traffic passing through the flood risk area to other routes

Institutional Gaps

Based on the above institutional analysis and case study, it is evident that there are major institutional gaps. These gaps may be bridged by implementing the proposals presented below.

Planning Stage

At planning level, there must be co-ordination taking into account the local geomorphology/ catchment area characteristics.

1. It is most vital to record on maps the actual water ways and not only the marks on the ground of the water ways.
2. The right of way of storm water must be secured. This must be evident on all title deeds through which there is storm water flow.
3. In urban plans, storm water drainage must be one of the parameters to be taken into consideration. The continuous, smooth and adequate flow of storm water must be ensured.
4. All competent bodies mentioned above must co-operate under the lead of one Department (e.g. Town Planning) and produce a masterplan of urban storm water drainage.

Implementation Stage

At implementation level, the drainage system can be constructed at the lowest possible level, by the Municipality, or Community or a cluster of Municipalities/ Communities, depending on the scale and extent of the drainage system.

Maintenance responsibilities should also be allocated to the lowest possible level.

For both new and maintenance works, all Local Authorities must acquire a licence from a co-ordinating/ higher Authority. Such Authority could be the District Officer.

Audits

The Environment Service and the Audit Service should have powers to:

- Report on experienced damages and make recommendations for avoiding the recurrence of such damage
- Request statements from Public Bodies which execute works if the works are executed as planned and approved

Conclusions

Although Cyprus has an acute water shortage problem, at the same time it suffers frequent and recurring urban flooding problems. Institutional analysis has highlighted the existence of gaps (and overlaps) in the management of urban storm water drainage. With the aid of a case study, a set of proposals are developed which bridge the existing gaps and establish procedures for the continuous monitoring and improvement of the responsibilities and jurisdictions of the public institutions.

In the meantime, a set of measures are proposed which aim in minimising the risk of urban storm flooding damage.

Responsibility	Urban Storm Water Drainage System			Comments
	Planning	Implementation/ Maintenance	Damage Assessment/ Mitigation	
Town Planning Department	No	Some cases	No	
Water Development Department	No	No	No	Competent Authority for natural rivers (irrespective if urban area)
Municipalities	No	Yes	No	Within municipal boundaries
Community Councils/ District Officer	Yes	Yes	No	Within Community Boundaries
Public Works Department	No	Yes	No	For roads under its jurisdiction only
Ministry of Commerce	No	Yes	No	Within industrial estates boundaries
Sewerage Boards	No	Yes	No	Limited number of Sewerage Boards have jurisdiction for storm water drainage – Mainly for sewage
Lands and Surveys	No	No	No	
Audit Service	No	No	No	
Environment Service	No	No	No	
Civil Defence	No	No	Yes	

Table 1. Institutional Analysis – Summary Table

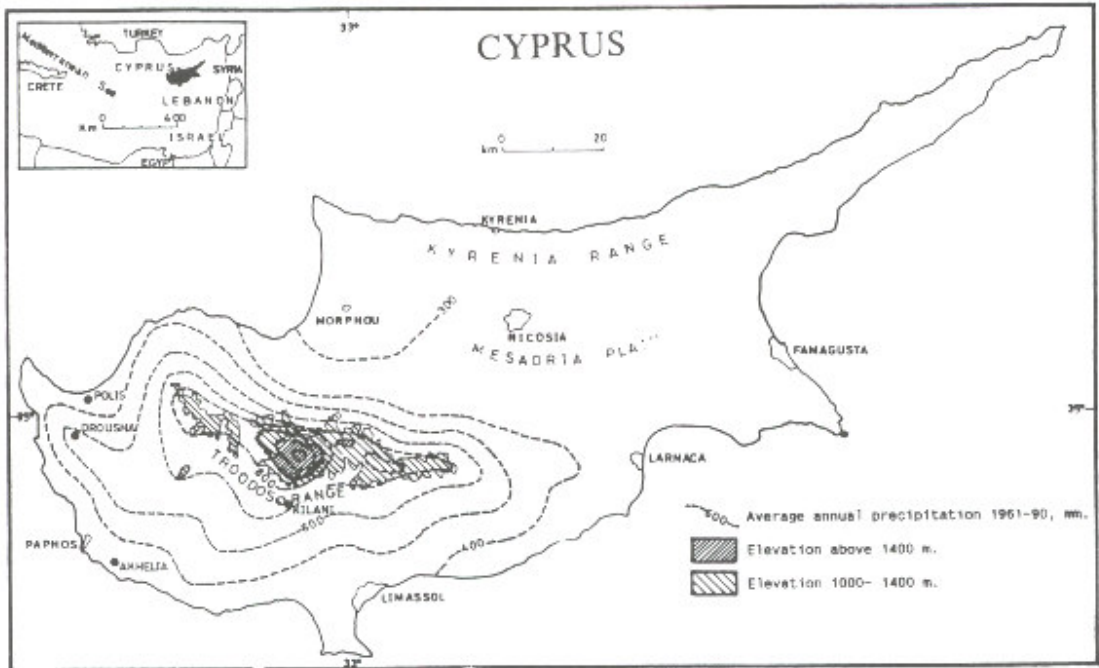


Figure 1. Cyprus. Location plan and Average Rainfall

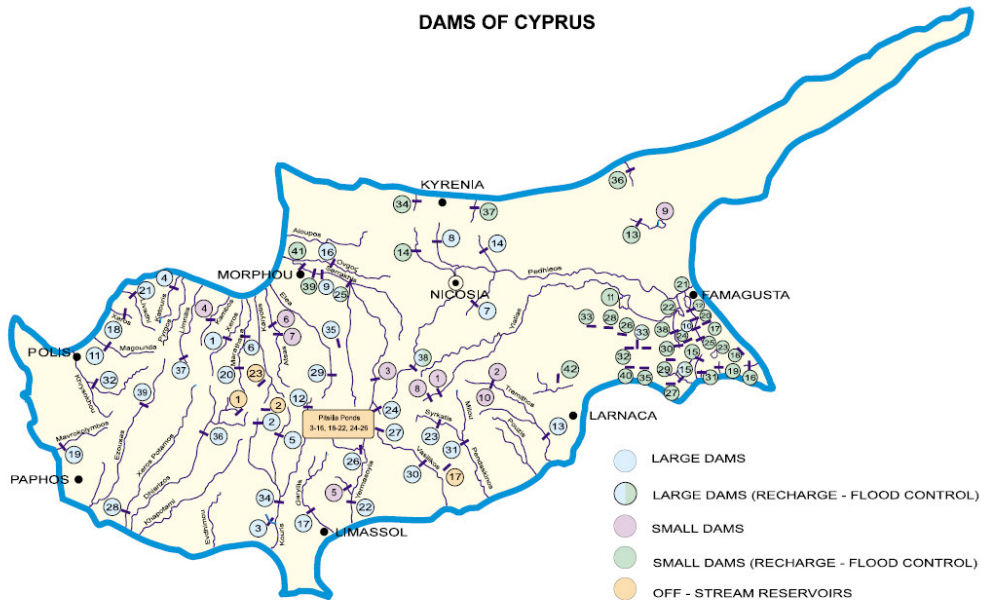


Figure 2. Dams of Cyprus



**Figure 3. Storm sewer with dead end at boundary between two Municipalities.
Photographs taken during storm water sewer construction soon after and
few days after rainfall.**