# DETERIORATION AND FRAGMENTATION OF RIVERS IN MALTA

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## Introduction

Malta, situated in the Mediterranean Sea south of Sicily, is a small island of less than 300 km$^2$, comparable in size to the Isle of Wight. It is physically diverse, composed of Coralline limestone plateaux reaching almost 300 metres in height, blue clay slopes below the plateaux, undercliff areas where limestone meets the sea, flat basins (due to faulting, erosion and deposition), and *Globigerina* limestone areas of gently sloping land. Surprisingly, for such a small area, Malta has ca. 100 km of sizeable watercourses and ca. 200 km of minor ones.

Being -in the Mediterranean, rain typically falls mostly between October and March, and storms may be heavy, with much runoff. The annual average rainfall is just under 500 mm, comparable to parts of eastern England. Although very variable from year to year, there has been no overall change since records began in 1841 (Bowen-Jones et al. 1961; University of East Anglia Climate Unit, private communication). Recent change in the amount of surface water on Malta cannot, therefore, be attributed to climate change.

## The present dryness of Malta

Malta's present appearance is of a dry and barren land, without the lush forests or vineyards of, for example, Corsica or Crete. Many rivers are dry (except after cloudbursts), none flow properly throughout the year, and few have even a perennial trickle. Marshes (except in river beds) are barely existent, and a few acres of recently-excavated bird reserve do not compensate for this general lack of surface water.

A surprisingly wide variety of crops are grown, but these rely on the winter rainfall and, increasingly, on irrigation water.

## The former wetness of Malta

Two hundred years ago Malta was a wet and sodden country. The limestone was like a sponge, with numerous perennial springs, great and small, and so full of water that most flat areas did not drain, but were marsh. Water from springs, rivers and marshes was in ample supply.

The evidence for this wetness comes from many sources, enumerated below.

(1). Laws requiring drainage of marshes by landowners. These became stringent in the 1830s when the relationship between water quality and public health became known. (Drainage had previously been piecemeal, often not lasting, and for improved agriculture). The last and largest marsh, Marsa (= marsh), was drained in the 1860s (Cassar 1965).

(2). Laws concerning other waters, in particular those repeatedly prohibiting farmers from collecting irrigation water after June from the Upper Sewda, beside the old capital of Mdina (it was presumed such water was responsible for the summer fever (Cassar 1965)). This valley is now quite dry even in a winter with double the average rainfall (about 900 mm). To explain repeated laws, there must have been much surface water during the dry Mediterranean summer.

(3). The 1853 Flora by Grech Delicata specified ten wet habitats, including small rivers, slow-flowing waters, common standing waters, places which flood most of the year, watery places, marshes, and damp places. There can be no mistake in the terms used, or in the species present. Standing waters and damp places were both present at the time, and they are different.

(4). 19th-century landscape pictures show rivers full of water. That in itself is not firm evidence, as the larger ones can still be so - occasionally. The pictures, though, show paths or tracks above this high water level and not, as now, below this level. An example is shown in Figure 1 (upper picture).

(5). Limestone is readily but differently eroded by rainwater and riverwater, making it possible to see (at suitable limestone outcrops) the old main river level. For one locality (Fig. 1, upper) there is also a mid-19th century picture, proving that the river level shown by the rock now is the same as that in the picture.

(6). Historical records from Roman and Arab times show that crops needing a good water supply grew well (Haslam et al. 1977).

(7). Folklore-sayings include water, which would be most unlikely if water was hard to find. Examples are: do not stir stagnant water, for it will stink; do not get near turbid water; splash along, gander, since you have found water

FIG. 1 *(on opposite page).* Two Maltese river-courses. *Above:* Saint Paul's Cave Church near Mosta (at centre of photograph), with the River Ghasel (at bottom of photograph). The bed of the river has dried out and now most of it is used to grow crops. *Below:* the River Sewda. The bed (left centre of photograph) has dried out and is overgrown with vegetation, a roadway has been built up on one side and rabble has been tipped to form a rough "bridge" across the old riverbed (at bottom of picture), forming a potential hazard in times of flood.

(good quantities are traditionally needed for geese). There are also references to water-wheels and newts, which are no longer present (Aquilina 1972; Pullicino 1992).

(8). Causeways in a former marsh (Salini) now stand more than a metre above (dry) ground level.

(9). People born between the late-19th century and the 1950s have noticed and noted Malta drying up: as also has this writer, though only from the 1960s.

Considering the wide range of the above evidence, the general conclusion is inescapable: the surface of Malta has dried up in the last 200 years.

## Land drainage

Land was repeatedly drained in the past, but only from the 1830s was it significant and final. The motive was excellent: improvement of public health, and this objective was achieved. The loss to conservation was inevitable, when drainage was the only means of eliminating mosquitoes etc., before the advent of synthetic pesticides.

The drainage, as usual in the 20th century, has been maintained; waterlogging after severe storms is not wanted for crops. Farming is more intensive, so there is more runoff and flash-floods, greatly exacerbated by the now-huge area under roads, houses, gardens, factories and other buildings (estimated to cover up to one-third of the island). Rain falling on to concrete cannot sink into the soil, and roadways form an alternative drainage network, carrying water rapidly away from the land and into the sea.

Thus increased drainage has dried-out the surface soils of Malta and greatly decreased the amount of water percolating down into the rock aquifers. At the same time, abstraction of water has increased.

## Abstraction

Large-scale abstraction from the main (or lower) rock aquifer started over a century ago, and is still increasing. Formerly there was a "lens" of fresh water within the *Globigerina* and lower coralline rock, lying above but in continuity with the sea water below (Bowen-Jones et al. 19961), but it eventually turned brackish through over-abstraction in the 1980s. 60% of the water now supplied in the main distribution network is treated by reverse osmosis, and even so it is neither palatable nor recommended for babies.

Abstraction is also considerable from the upper water tables, and though it is increasingly too polluted for drinking supplies, it is used for irrigation.

Springs formerly flowed plentifully. In the 1920s all but the highest springs flowed a little all year round (Borg 1927), whereas now only a few still run during the summer months, with greatly reduced flows.

## Changes in rivers

Two centuries ago, spring-fed water in the rivers was plentiful, much was perennial, and the water quality was that of unpolluted limestone.

The Flora published by Grech Delicata (1853) is incomplete, but the river plants recorded therein (Table 1) clearly represent a good south European limestone flora (Haslam 1987). Of these, the comparable 1990s list now only contains waterplantain *Alisma plantago-aquatica*, galingdale *Cyperus longus*, and common duckweed *Lemna minor* agg. Additional species are: fool's watercress *Apium nodiflorum*, whorled watermilfoil *Myriophyllum verticillatum*, watercress *Nasturtium officinale*, *Chara* spp. and long filamentous algae (e.g. *Cladophora*). This present flora is so degraded it does not even indicate a limestone influence. The river-flow now is derived from contaminated and erratic rainwater, with some effluent (amid a trivial amount of spring water). Formerly it was spring-regulated limestone water, added to by rainwater which had collected some nutrients from the soil.

Table 1. Plants recorded by Grech Delicata (1853) in Maltese rivers.

| | |
|---|---|
| *Alisma plantago-aquatica* | *Mentha aquatica* |
| *Apium graveolens* | *Oenanthe globulosa* |
| *Apium inundatum* | *Ranunculus fluitans* |
| *Colocasia esculenta* | *Ranunculus trichophyllus* |
| *Cyperus badius* | *Scirpus holoschoenus* |
| *Cyperus longus* (edges) | *Scirpus lacustris* (still) |
| *Cyperus papyrus* | *Scirpus maritimus* |
| *Eleocharis palustris* | *Sparganium erectum* |
| *Glyceria maxima* | *Typha domingensis* (still, slow) |
| *Glyceria permixta* | *Veronica anagallis-aquatica* |
| *Glyceria plicata* | *Veronica beccabunga* |
| *Juncus effusus* (still edges) | *Zannichellia palustris* |
| *Lemna minor* (still, slow) | |

## Fragmentation of rivers

Once rivers have dried out, they are no longer significant in terms of direct water supply, although the fact that contaminated water can still enter a watercourse and sink the short distance into the aquifer below, is usually forgotten. When mild and locally-damaging floods occur only about one year in five, and severely damaging floods occur perhaps one year in fifty, these events are ignored and conveniently forgotten. Therefore, the dry bed of a watercourse can become fragmented and indeed it may be built on (Front cover picture). Fragmentation may occur in numerous ways. Long stretches may be bulldozed "to prevent floods". When the bed is so dry anyway, this leads to invasion by ruderals (plants of wasteland and disturbed places), rather than recolonisation by marsh (or water) plants, so communities of the latter are separated by long bands of ruderals. The empty bed of a watercourse may also be used as a road. Or it is filled with quarry waste and rubbish, or rubble to make an easy bridge across the channel, and buildings may be erected (resulting in an unpleasant shock in due course!). Farming often encroaches on the dried river channel; this is slightly more acceptable, but it fragments the wetter habitat. Beds of cane *Arundo donax* are not managed properly, so that *Arundo* has become monodominant for stretches of 1 km or more, its dense litter and shade keeping out other plant communities. In some places exotic trees such as Australian *Eucalyptus* and *Acacia* have been planted. These, naturally, bear a poor invertebrate fauna, as well as preventing native plant communities from developing.

The total length of the main watercourses on the island is only ca. 100 km, and it is now difficult to find a 1 km length without some form of fragmentation.

## Concluding comments

In the space of two centuries, Malta's rivers have passed from being good, spring-regulated watercourses with a mixed community of clean limewater plants (presumably supporting a comparable aquatic fauna), to the present-day situation where many if not all are on the verge of extinction. This is the result of human impact, not climate change, and is set to continue and increase.

Unfortunately the best wetland-type valley communities were scheduled to be destroyed in 1997 but, after a change of Government and vigorous representations, these may now be spared. However, there is at least a great opportunity to prevent further fragmentation of remaining rivers and to reclaim some of the fragmented portions.

The problems arising from human interference are not exclusive to Malta. For example, the much larger Mediterranean island of Majorca is geographically two regions. In the mountains there is both more rain and a non-porous surface, and rivers flow well. In the fertile and more-populated lowlands, the rivers now are even drier than in Malta, for similar reasons. One can also see a similar loss of surface water and degradation of watercourses in southern England!

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