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IMPLICATIONS OF EXPECTED CLIMATIC CHANGES ON THE ISLAND OF MALTA

IMPACT OF GLOBAL WARMING ON POPULATION AND SETTLEMENT PATTERNS

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Background

Whereas predictions of precipitation patterns remain as yet nebulous, perhaps the most accurately established consequence of global warming is sea-level rise. According to IPCC-Working Group I, a global sea-level rise in the range of 30 to 110 cm will take place by the year 2100 on a "Business as usual" scenario with a best **estimate of 66 cm.** This rise is mainly attributed to thermal expansion of the upper ocean layer and to melting of glaciers and small ice caps. This rise would continue, albeit to a lesser extent, even if preventive measures to limit man's contribution to global warming are effectively applied now under IPCC's scenarios "B" and "C".

On top of these absolute values of sea-level rise, the local land subsidence contributes to a further rise which could be significant.

The most obvious impact of a sea-level rise is the loss of land attributed to the encroachment of shorelines. Sea-level rise also adversely affects drainage systems, making them more vulnerable to flooding as the gravitational gradient is reduced. These factors have a direct impact on population patterns as settlement is adjusted to the new conditions of availability and use of land.

The Coastal Zone Management Subgroup of IPCC has examined the physical and institutional strategies needed to combat the potential hazards on population and settlement patterns arising from a sea-level rise. The Subgroup recognized three categories of remedial action: retreat, accommodation and protection.

Retreat involves the abandonment of land following seawater invasion. Accommodation implies the continued use of land under new living and economic conditions including the use of emergency flooding shelters, elevated structures on piles and adjustment to an aquatic economic practice. Protection involves the erection of hard structures such as dikes and the implementation of dewatering schemes.

Malta, on the whole, is not particularly vulnerable to a sea-level rise on account of a favourable topography, good drainage and negligible land movement. Nevertheless some densely populated zones along the coast and particularly along the principal drainage lines will be affected to some extent and some level of anticipatory action will be needed to cope with any consequential economic and social disruption.

VERTICAL LAND MOVEMENT;

Malta is located on the extensive Pelagian Platform of the North African Plate. It therefore falls outside the orogenic belt of the Tunisian Atlas - Sicilian Overthrust Belt and tectonic movements are consequently relatively small and characterized by extensional faulting.

This faulting is closely linked to the structural adjustment of the Platform to the relative movements of Africa and Europe from Triassic to present times. One result of this adjustment is the dissection of the Platform by the Pantelleria-Malta rift system in the Plio-Quaternary. One fault of this system (the Malghaq fault in the south of Malta) uplifted the Island above sea-level and produced the present day gentle NE structural dip.

On the basis of seismic evidence of drowned shorelines in offshore Malta, the sea-level rise in Malta over the past 18,000 years averages at about 140m. This is of the same order of magnitude as the global average rise since the last glaciation and would indicate that in spite of the presence of slickensides along the face of the Malghaq fault, there has been little, if any, absolute vertical movement of the land during this period. The impact of land movement on sea-level rise in Malta can therefore be ignored.

SETTLEMENTS AT RISK:

(a) Coastal Settlements:

The geography of land-use and demographic patterns in Malta shows that geology was a key factor in determining the spatial distribution of urban and rural areas. Most villages are congregated around outcrops of available building stone, the Lower Globigerina Limestone, whereas arable land is concentrated on outcrops of formations which easily weather to a fertile soil, the Blue Clay and Middle Globigerina Limestone. The difficulty of erecting structures on these latter soft formations also contributed to the absence of settlements on these outcrops.

Settlements along the coast were primarily limited to port areas like Valletta, Senglea, Victoriosa and Cospicua but later extended to other coasts primarily for recreational purposes. For instance Sliema, which today constitutes Malta's most densely populated area, originally started as a summer residence for the city dwellers. Recreational settlements along other coastal areas spread in recent years to B'Bugia int he south and Bugibba and St. Paul's Bay in the north of the Island.

In spite of this recent attraction to coastal settlement, the topography of the Island is relatively rugged with only a few low-lying coastal areas. Here, settlement is discouraged by the presence of thick deposits of alluvium and silt which favour agricultural use of the land (Burmarrad, Marsa, Pwales and Mellieha Valleys).

Topographic maps of the Island are available on a contour interval level of 25 feet (8 m). Assuming a sea-level rise of 66 cm. and a negligible land movement by the year 2100, the 1m. elevation contour can be considered as a good marker to assess the extent of seawater encroachment on the Island. Interpolation of the 1m. contour on the built-up area map would suggest that any consequential disruption of social activity arising from a sea-level rise would be very small and limited to the Strand-Pieta-Msida-Marsa sea-fronts (Frame A), Marsascala, Marsaxlokk and parts of B'Bugia sea-fronts (Frame B). Assuming an equal population density, a total population of about 20,000 may be affected by sea-water invasion following tidal and storm surges along these coasts. This represents 7% of the total population of the Island, by no means a significant figure when one considers that these areas have already reached maximum population growth.

Of the three remedial actions that may be employed to combat sea-water invasion, elevating the coastal risk area by means of back-filling would represent the easiest and most cost effective protective measure.

(b) Settlements along Drainage Systems:

Malta is divided into two main morphologic units by the Victoria Lines Fault. North of this fault the Island is broken up into a number of horsts and grabens by less pronounced faults. Drainage is parallel to the general stike of these horsts with few intermittent streams flowing into the bays to the NE. An exception to this pattern is a major drainage line which has an origin near Rabat in the southern unit and crosses into the northern unit with an outflow at Salina.

The only populated area found in a drainage line of this morphological unit is at Burmarrad (Frame C) where flooding, which is already a problem, will get worse as drainage gradients are reduced with a rise in sea-level.

The second unit lies south of the Victoria Fault. The eastern half of this unit has the Globigerina Limestone as the prevailing outcrop forming a gently rolling landscape. This outcrop provides the building stone in Malta and has undoubtedly contributed to the dense settlement in this part of the Island. Three main drainage systems are found here, one converging into Valletta Harbour, one flowing into Msida Creek and the other into Marsaxlokk Bay.

Some densely populated areas are found along all three major drainage systems of the second unit. In particular, we find the low-lying parts of B'Kara, Msida, Qormi and Marsa (Frame A) located along these drainage lines which are already prone to flooding after heavy downpours. Further reduction in the gravity gradients of these systems will inevitably make these urban areas far more susceptible to flooding.

CONCLUSIONS AND RECOMMENDATIONS:

A global mean eustatic rise of about 66 cm by the year 2100 would have little impact on the population and settlement pattern of Malta.

Disruptions are more likely to result from temporary tidal and storm surges along the coasts and flooding of drainage systems during heavy rainfall rather than from permanent land drowning.

In line with IPCC's recommendations on the implementation of adaptive measures by coastal nations, Malta should nevertheless implement a comprehensive coastal zone management policy by the year 2000. The policy should include the precise identification of all coastal areas at risk and their subdivision into habitable, industrial and agricultural areas.

Emergency plans should be formulated and put in force to adequately cope with any eventual flooding even if it is temporary.

Drainage in the B'Kara-Msida, Qormi-Marsa and Burmarrad areas should be improved by means of adequate culverts.

Monitoring of sea-level rise by means of tide-gauge data collection should also be initiated. Links with international organizations and networks should also be maintained for scientific and technical assistance.

The present population growth in the low-lying risk areas should be stopped. Anticipatory regulations as well as economic incentives and compensation should be introduced to shift some habitation in critical areas, such as parts of Msida, to safety with the least disruption.