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Status of soil surveys in Malta

D.M. Lang is responsible for the only detailed study of the soils of Malta and Gozo (Lang, 1960). The soil survey was carried out from 1956-57 and finalised in 1960 with a soil map of the Maltese Islands published at a scale of 1:31,680 (2 inches to 1 mile). Lang's main objective of the soil survey was to provide basic descriptions of the soils and map their distribution as an aid to agricultural planning. In view of this he mapped differences in chemistry, physics, and biology of the soil, as reflected in soil colour, texture, and structure, in conjunction with the landscape type.

The geological and climatic controls have been very distinctive in the genesis of the soils of Malta and Gozo. However, the existing soils are complex and difficult to categorise owing to centuries of intense human activity. To accommodate for this, Lang used profiles relatively untouched by man. The principal modes of soil disturbance are carting, quarrying, manuring and terracing.

Soil constraints for agricultural production

The soils of Malta and Gozo are rather young or immature soils, due to the fact that pedological processes are slow in calcareous soils. The soils are described as largely artificial, being man-made or altered, and highly calcare-

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ous, so that in the Mediterranean climate the evolution of morphology is slow and the dynamic not clearly defined.

The climate of Malta and Gozo is a good example of the Mediterranean type: hot dry summers, having a high rate of evaporation and no rain warm and showery autumns normally with a rainfall deficit, short cool winters with enough rainfall for agriculture in most years, but leaving insufficient reserve in the soil to combat the warm drying springs again having a rainfall deficit. This uniformly arid climate is the reason for the restricted range of soils found in the Maltese Islands, and for the lack of development of noticeable humus horizons.

The carbonate raw soils and Xerorendzinas, (Kubiena 1953) are immature soils of similar genesis, both having developed from weathering of the Globigerina limestone. These fine textured limestones impede the percolation of rainfall, which accounts for the raw nature and high calcium carbonate levels of these soils. The total organic matter is in general very low.

The most striking feature of the soils is the high content of calcium and magnesium carbonates in the whole profile. Although the high amount of calcium carbonate influences plant growth by effecting uptake of certain nutrients, it prevents the accumulation of sodium in the exchange complex and hence minimises alkalinity hazards as a result of irrigation with highly sodic water. The relatively raw, newly exposed soils developed on the Blue Clay (Fiddien heavy clays) are sometimes markedly alkaline and slightly saline. These soils are either unused or producing only very poor crops because they are very difficult when wet and when dry are hard and rock-like. In some locations, heavy textured soils of the Xerorendzina group are salinised, and out of agricultural use.

The depth of the soil and soil material is very variable. On the ridges, plateaux and plains (erosion surfaces), the soils are very shallow ranging in depth form less than 20 cm to about 60 cm. Deeper soils occur only in isolated pockets. In the erosional and structural valleys, the soils are deeper (150 cm), but patches of shallow soils are very common, especially near the valley edges.

Although the extent of salt-affected soils is not well documented, there is plenty of evidence to suggest that salinity is a soil constraint for agricultural production. The hydrogeological features of the Maltese Islands, the Mediterranean non-leaching climate, and the scarcity of fresh-water resources, constitute predisposing factors for the accumulation of salts and provide the setting for salinity-related phenomena to emerge and develop. Irrigated land is by far the most productive, however, much irrigated land has already become saline, as is the case in the Pwales valley, where due to the seawater intrusion and over-abstraction of the groundwater resources, salt crystals may be observed on the soil surface. Studies by the Department of Agriculture have indicated that the problem of soil salinity is most salient in greenhouse production systems (Camilleri, 1999).

Environmental problems related to soils

The existing national legislation and policies (Box 1) are inadequate to provide a legal framework for the protection and conservation of soils. Provisions to protect soil against activities contributing to soil erosion (e.g. reclamation of watercourses, reclamation of land that is exposed and/or steeply sloping, deforestation and/or clearing of wild vegetation) are absent and need to be added. Current legislation is primarily directed towards regulating activities leading to soil disturbance in large quantities, and does not provide for the preservation of the soil’s health, quality and fertility status.

The **Fertile Soil (Preservation) Act**, 1973 and the **Preservation of Fertile Soil Regulations**, 1973 [L/N 104/1973] protect fertile soil by prohibiting:

Unauthorised transport of soil.
Admixture of soil with material in ways which would sterilise it.
Deposition of material on soil, or covering of soil with material.
Building upon soil.
Deposition of fertile soil on land already covered with 1m of soil.
Deposition of soil in heaps or in any manner which would render it unsuitable for immediate cropping.

The **Rubble Walls and Rural Structures (Conservation and Maintenance) Regulations** [LN 160 of 1997] protects rubble walls and non-habitable rural structures in view of their exceptional beauty, their habitat for flora and fauna and their vital importance in the conservation of soil and water. This regulation prevents any person from demolishing or endangering by any means whatsoever, the stability and integrity of any rubble wall, and therefore indirectly controls soil erosion.

The **Motor Vehicles (Offroading) Regulations** [Legal Notice 196 of 1997] indirectly reduce erosion risk, by preventing activities that have an impact on soil structure. No person is allowed to drive any motor vehicle other than in a locality, which is marked as an offroading site.

Specific policies related to the conservation of soil are outlined in the **Structure Plan for the Maltese Islands (1992)**:

Policy AHF4: Soil conservation and soil saving measures will continue to be mandatory on all occasions. Soil replenishment measures will be adopted where there are suitable opportunities.
Policy RCO24: Existing regulations concerning excavation and transport of sand and soil will continue.
Policy RCO25: Positive action will be taken to promote the repair of breached retaining walls on valley sides in order to prevent further soil erosion.

Box 1. National Legislation and Policies

Translocation and urbanisation effects

Since the date of issue of the soil map produced by Lang (1960), considerable translocation of topsoil and regolith has occurred, together with occasional mixing of soil with other material. These interventions have generally been associated with:

site clearance for development;

infilling of disused, or partly exhausted, quarries;

'reclamation' of land for agriculture and soft landscaping of development sites;

disposal of excavation debris;

overspill from development sites;

valley engineering projects.

The volume of soil relocated by the private sector is not recorded, and rough estimates derived from measuring the land areas given over to development have high margins of error, due to:

non-uniform soil depth

numerous developments scattered in the countryside (individual areas are difficult to estimate)

numerous small-scale and/or illegal (and therefore undeclared) developments that are not recorded in official documentation (e.g. trapping huts and other rural rooms);

illegal burial, dumping, translocation and/or mounding of soil, as well as illegal admixing of soil with other material.

Access routes

Following increased mechanisation of agricultural activity, numerous roads and tracks for vehicular access to remote rural areas were opened. In relatively recent times, many tracks have been widened and surfaced, some by the Department of Agriculture through an ongoing scheme for the improvement of rural areas, others by Local Councils, and the rest by individual farmers or groups of farmers. Whilst assisting farmers in reaching their land with-out undue hardship, this practice also has a number of important environmental impacts, including:

An increase in the quantity and velocity of runoff in the case of impermeable surfaces, especially if located on steep valley sides or within a valley bed. The ultimate effects include increased soil erosion and structural damage to rubble walls.

Tracks surfaced with spalls, hardstone dust, poor-quality asphalt/concrete, or other loose material gradually release gravel, which increases the physical erosive capacity of runoff water, thereby promoting soil loss and sedimentation of watercourses.

Soil erosion

Under natural conditions the soils are easily eroded in a climatic regime of a long dry summer and a wet season in which rain frequently falls in heavy showers. The actual field situation in Malta gives rise to most erosion in marginal areas, where the retaining stone walls are in a state of disrepair.

The phenomenon of soil erosion constitutes a major ongoing problem throughout the whole Maltese countryside, especially in valleys. Erosion appears to be on the increase owing to a number of factors, which include the following:

Dereliction and subsequent collapse of soil-retaining random stone walls;

Deliberate/accidental damage to soil-retaining random stone walls as a result of snail-collecting, offroading and motorised scrambling, and infrastructural and/or maintenance interventions such as trenching, dredging, and cleaning/'weeding' of country roads;

Breaching of soil-retaining random stone walls to provide new access points to fields;

Replacement of random stone walls with less adequate structures (for example walls that lack weep-holes often collapse when the soil becomes waterlogged);

Abandonment of traditional runoff management structures (e.g. tunnels constructed in rubble walling underneath cultivated land);

Clearing of vegetation from uncultivated land;

Localised deforestation;

Compaction of soil surfaces as a result of the passage of heavy vehicular traffic associated with offroading and motorised scrambling, as well as with general access and parking in (and/or around) popular recreational areas, hunting areas, trapping sites, agricultural areas and isolated rural buildings/hamlets;

Clearing of vegetation, deposition of material, compaction and inhibition of plant growth (using herbicides) for the preparation and maintenance of trapping sites;

Reprofiling of land into steep escarpments;

Excavation on sloping ground;

Downslope ploughing;

Modification of soil structure through the excessive use of fertilisers (nitrates, in particular, are known to oxidise soil humus, rendering the soil crumbly and readily erodible);

Lack of attention to incipient gullying;

Deposition of soil and other material (for agricultural reclamation, 'temporary' storage, or permanent dumping) on sloping ground prone to runoff-induced erosion, and on land exposed to wind;

Reclamation of land in valley beds and watercourses;

Construction of impermeable surfaces (e.g. buildings, paved areas) on valley sides and valley catchments;

Rendering rural tracks impermeable, especially those on sloping ground and within valley beds, thereby increasing the quantity and speed of water runoff.

Beyond a few specific case studies, there is little existing information on soil erosion in the Maltese Islands, and no systematic erosion status/erosion susceptibility database.

Photo 1. Rubble walls show their exceptional beauty, their habitat for flora and fauna and their vital importance in the conservation of soil and water

Photo 2. Even the existing regulation prevents demolishing or endangering the rubble walls increased soil erosion brings to their structural damage

In order to assess soil erosion in the Maltese Islands, a national team is currently undertaking preparatory works for a Soil Erosion/Desertification Assessment and Mapping activity scheduled to start in January 2000. This project is integrated within the Coastal Area Management Programme (CAMP) for Malta. The institutions responsible for the co-ordination of the various activities are the Priority Actions Programme/Regional Action Centre (PAP/RAC), the Land and Water Division of the Food and Agriculture Organisation (FAO/AGL), and the Environment Protection Department of Malta (EPD). The objectives of the erosion study are to introduce and apply the FAO/PAP consolidated mapping methodology to selected pilot areas and make recommendations for prevention/rehabilitation techniques.

The implementation of this project is based on the principle of sustainable development presented in Agenda 21; principles of the Guidelines on Integrated Coastal Area Management (ICAM) developed by PAP-UNEP and of Guidelines for Erosion Mapping and Measurement (PAP/RAC in collaboration with FAO). The expected project outputs will include basic digitised maps of erosion status and dynamics, supply of GIS and mapping equipment, photo catalogues and improved land use plans. The final product of this project will be the physical assessment of erosion-prone areas and its documentation in a cartographic database. This activity is in line with the implementation of the United Nations Convention to Combat Desertification. Through the ratification of this Convention, the Government of Malta has taken the first measures towards soil conservation.

Soil maps and supporting data

The only soil map of the Maltese Islands is that published in 1960 on a scale of 1:31,680 as a result of the study of the Maltese soils by D.M. Lang in 1956-57. The existing soil map has never been digitised because it is regarded as outdated and consequently of little use for land management and planning purposes. Since the date of issue of the national soil map produced by Lang, considerable translocation of topsoil, subsoil and regolith has occurred, together with occasional mixing of soil with other material. The soil descriptive and analytical data as a result of this survey are older than 40 years and do not correspond to the field anymore. This is especially true in areas having strong human-influence. A list of national maps and supporting data is included in Appendix A.

Conversion of national soil legend into international systems

In classifying the soils of the Maltese Islands, Lang adopted the system developed by Kubiena (1953) (Box 2). According to this classification system three sub-types were recognised: carbonate raw soils, Xerorendzinas and Terra soils.

Division	Class	Type	Sub-type	Variety	Locality/Series
A. Subaqueous					
B. Semi-terrestrial	BA. Semi-terrestrial raw soils	VI Rambla	12. Chalk Rambla		Ghadira Alcol
	BD. Salt soils				
C. Terrestrial	CA. Terrestrial raw soils	XXIII Syrosem	50. Carbonate raw soil		Fiddien, San Lawrenz, Nadur, Ramla, part S.B.
	CC. Rendzina-like soils	XXV Rendzina	60. Humid Rendzina	(36) Protorendzina	Malta E., Malta P.
				Mull rendzina	
			61. Xerorendzina	Xerorendzina	San Biagio, Alcol, Tal-Barrani
	CE. Terrae Calxis	XXXIII Terra	74. Terra fusca	(47) Earthy Terra fusca	Xaghra, Tas-Sigra
			75. Terra rossa	(48) Siallitic terra rossa	

Box 2. Classification of Maltese soils according to Kubiena (1953)

In the early 1970's, an FAO consultant mission (Sivarajasingham, 1971) prepared a report on the soils of Malta within the scope of a WHO special Fund Project on Wastes Disposal and Water Supply to study the nature of the soils in prospective irrigation areas and to assess their suitability for irrigation with treated sewage effluent. On the basis of this study, areas of soils were demarcated on a topographic base map according to defined irrigation suitability classes. The same study provides a tentative classification of Maltese soils into families according to USDA (Box 3) and FAO systems (Box 4). A more detailed analysis of the classification of Maltese soils is included in Appendix B.

Ramla	sandy, carbonatic, calcareous, Typic Ustor-thent
Nadur	coarse loamy, carbonatic, calcareous, Typic Ustorthent
Fiddien	fine clayey, mixed calcareous Typic Ustorthent
San La-wrenz	fine loamy, carbonatic, calcareous Typic U-storthent
San Biagio	fine loamy, carbonatic, calcareous Lithic Typic Ustorthent
Alcol	fine loamy, carbonatic, calcareous, Rendollic Ustochrept
Tal-Barrani	fine loamy, carbonatic, calcareous, Rendollic Ustochrept
Xaghra	fine clayey, mixed calcareous Typic Ustochrept
Tas-Sigra	fine clayey, mixed calcareous Typic Ustochrept

Box 3. Classification of Maltese soils according to USDA system (Sivarajasingham, 1971)

Ramla	Calcaric Regosol
Nadur	Calcaric Regosol
Fiddien	Calcaric Regosol (in some places Chromic Vertisol sodic)
San Lawrenz	Calcaric Regosol
San Biagio	Calcic Cambisol lithic
Alcol	Calcic Cambisol
Tal-Barrani	Calcic Cambiso
Xaghra	Chromic Cambisol
Tas-Sigra	Chromic Cambisol

Box 4: Classification of Maltese soils according to FAO system (Sivarajasingham, 1971)

National soil institutions

In the absence of a national institution responsible for soil survey activities, mapping and monitoring, soil information has until the present day received little attention and remained a relatively undeveloped agricultural field in Malta. Soil information is very fragmented and linked to specific surveys and studies carried out by undergraduates or as part of environmental impact assessments for project location and development purposes.

The Agricultural Research & Development Centre has a soil fertility and salinity monitoring programme in relation to commercial fertiliser plans. The collection of soil data is restricted because of insufficient facilities for soil characterisation (field survey and laboratory analysis), and lack of expertise in soil science and soil geographic information systems. The laboratory methods for soil analysis are based on different methodologies (SSSA, FAO and MAFF) and are not standardised.

Suggestions for a Soil Information System in Malta

In the present situation, the need to provide the country with an operational tool for multifunctional use of the land and protection of the environment has never been as compelling as today, not only on account of Malta's EU accession prospects, but also in response to the demand by farmers and developers to obtain accurate information about the soil, this precious and limited resource.

Various objectives of soil protection dealing with predictions for safeguarding soil status, stabilisation and remediation require detailed knowledge about soils, their potential and actual loading.

It is proposed, therefore, to develop a soil information system for the Maltese Islands (MALSIS) to remedy current shortcomings and to allow for the preparation of thematic outputs that address a broad range of land use issues. This system would serve as a basis for decision making, policy regulation, planning and development at the national and regional levels.

The suitability of georeferenced soil databases has been demonstrated by a number of applications, which have already been made in different European countries. These applications include the protection of groundwater quality, the assessment of the risks of soil erosion, the assessment of drought hazards, the evaluation of land capability, the delineation of lands vulnerable to nitrate leaching, the assessment of risks of agrochemical pollution, the monitoring of vegetation ecosystems and desertification abatement.

Updating of the existing soil map for Malta is strongly recommended in view of the extensive translocation of soil and the urbanisation of significant tracts of former soil-covered land. In a report on the state of the environment in the Maltese Islands (Axiaq *et al.*, 1999), the need to survey the soil resources, and to develop a tool for the management of soil information, was identified as one of the most urgent priorities that the government should encourage and fund.

The implementation of many EU Directives aimed at protecting the environment requires detailed information about the soil resource base. Examples include:

EC Nitrate Directive (91/676/EEC);

Directive on Environmental Assessment (85/337/EEC);

Sewage Sludge in Agriculture Directive (86/278/EEC);

Habitats and Species Directive (92/43/EEC);

Directive on Integrated Pollution Prevention and Control (96/61/EEC);

Framework Directive on Waste (75/442/EEC).

The obligations originating from the Nitrate Directive, for example, require a soil data layer for delineating vulnerable zones, and a knowledge of the soil and crop growth conditions for the development of fertiliser recommendations and establishment of fertiliser (nutrient) plans on a farm-by-farm basis. In order to fulfil the obligations of the Sewage Sludge Directive, the background levels of heavy metals in soils must be determined before establishing rates of application of sludge on land.

Implementation and data acquisition

The recommended strategy for the development of a soil information system for the Maltese Islands is based on the Manual of Procedures for a Georeferenced Soil Database for Europe by the European Soil Bureau (Finke et al., 1998). It is proposed to carry out the required investigations and data acquisition by considering the Maltese Islands as a pilot area in the framework of the project to provide an increasing coverage of Europe with the construction of a 1:250,000 soil database.

As proposed, it is desirable to have pilot areas in most EU countries and national representatives should inventory regional and national interests. It is suggested to include the Maltese Islands together with Italy in pilot area no. 6 (Finke et al., 1998). In justifying the consideration of Malta as a pilot area, a number of important points can be highlighted:

The draft list of possible locations for pilot areas is lacking any representation from the central Mediterranean region. Therefore, the inclusion of the Maltese Islands as a pilot area would help in establishing the necessary representative coverage of European countries.

As a signatory to the Convention to Combat Desertification (CCD), national support exists to tackle the severe problem of land degradation in the Maltese Islands.

The choice of Malta as a pilot area would be a great source of experience; primarily for those involved at the local scale, but also for the technical experts.

If, according to preliminary analysis of existing data, it is concluded that Malta is unmapped, then compilation of data and development of a georeferenced soil database would be done according to standard methodology proposed by ESB/FAO thus eliminating the need for harmonisation of data.

As outlined in the Manual of Procedures (Finke et al., 1998), the work is to be carried out in a number of successive research phases. If Malta is identified and delineated as a pilot area, the following research phases should be carried out (Box 5). A more detailed diagrammatic representation is found in Appendix C.

Research phase	**Description**	**Comments**
Phase 1	Construction of a meta-database of existing information Overview of existing information within the pilot area (semantic and geographic knowledge) in a computerised metadatabase or a written report.	Existing information has been identified. The available soil data has been compiled into spreadsheets.
Phase 2	Screening, aggregation and use of existing data Data or maps screened on applicability and quality; useable maps are generalised to the appropriate scale; harmonisation of existing map legends to the definitions of soil bodies and soilscapes	Preliminary screening indicates that existing soil data is unsuitable for use. Verification of this is required.
Phase 3	Primary data acquisition Collection of new data in cases where: data is lacking or below standard; data cannot be harmonised; complementary data needed in addition to existing data; new forms of data are desirable	A programme of strengthening laboratory facilities and purchasing equipment is necessary. Technical assistance, together with extensive training of the national team, is needed to carry out the fieldwork. Estimated timeframe: 12 months
Phase 4	*Definition and delineation. Material collected is combined*	
Phase 5	Filling of the database Geometric, topographical and semantic parts of database are filled	
Phase 6	Validation Validation in a reference area to obtain an objective measure of predictive power of database	
Phase 7	Secondary data acquisition Use of pedotransfer function (PTF) and pedotransfer rules (PTR)	

Box 5. Research phases

Benefits and applications

The benefits of developing a Soil Information System for the Maltese Islands and potential applications in relation to national requirements have been identified and are listed in Box 6.

Applications of MALSIS	National Requirements
Description of the state of the environment	Detailed updating of the existing soils map was identified as an urgent priority by the expert panel in the State of the Environment Report (Axiaq *et al.*, 1999).
Environmental impact assessment	As established in the Environment Protection Act (1991), an impact assessment shall identify and assess the direct and indirect effects on the soil.
Risk assessment	Soil erosion risk maps could be used with hydrological data to model infiltration processes of unsaturated land zones.
Ecological rehabilitation of polluted sites	A soil database would provide a tool for drawing up policies for the protection of sites of scientific and ecological importance.
The base for research development, for new standard elaboration and for land use planning on appropriate level	A major problem in transferring technology and research to Maltese agriculture lies in the absence of detailed soil information.
Monitoring of the impact of natural factors and anthropogenic activities on soils	Extensive urbanisation, mixing and disturbance of topsoil is the major man-induced impact on soil which is not monitored.
Providing information for sustainable agriculture and rural development	Identification and protection of good grade agricultural land to ensure continued viability at present does not include soil quality criteria.
Providing information for the elaboration of soil and environment protection strategies	Soil information is a pre-requisite in elaboration of a Soil Code (the Code of Good Agricultural Practice for the Protection of Soil). At present there is no Soil Code for the Maltese Islands.
Providing information for the strategy and decisions on the control of soil fertility	The control of soil fertility is entirely absent from existing regulations and needs to be included. This is especially important in view of the need to adopt sustainable nutrient management plans, which have minimum impact on the environment.
Evaluation of soil protection measures and farm management practices	In the absence of a Code for the Protection of Soil, the farmers do not adopt soil protection measures. Soil information would provide the basis for recommending farm management practices, which aim at reversing trends in deteriorating soil quality.
Providing data for predictive models	In the absence of data on soils, predictive models cannot be applied. This is especially an important issue in the application of models for designating nitrate vulnerability of groundwater resources.
Serving as a basis of sound land use policy	In the absence of updated soil information, site inspections for evaluating applications for development permits reveal

	a large number of would-be coincidences wherein the interested sites are degraded beforehand.
Legal measures for soil protection (enforcement, penalisation, stimulation)	Provisions to protect soil against activities contributing to soil erosion are absent and need to be added to the national legislation.

Box 6. The benefits of the Soil Information System for the Maltese Islands

The current soil monitoring landscape in Malta is a highly scattered one. Apart from budgetary constraints for the establishment of a comprehensive national soil information system, there is not yet an unambiguous opinion about the institutional and organisational framework in which it could operate.

As recommended by the FAO/EC Technical Consultation on the European Soil Information System, national soil institutions should be responsible for collecting soil information and for monitoring of spatial and temporal changes in soil variables.

International efforts for co-operation should be directed towards establishing and strengthening of such bodies, so that local knowledge and experience is nourished. In the absence of a single organisation whether state-owned or private, responsible for soil information and soil monitoring in Malta, it is recommended that a permanent Soil Office should be established within the Department of Agriculture. This unit would be responsible for the management, maintenance and ownership of soil data.

Conclusion

The particular position of the Maltese Islands represents an important and strategic point of linkage between the European and the African reality from a geographic and climatic point of view. The development of a Soil Geographic Database for the Maltese Islands would constitute an important achievement in the extension of the European Soil Information System (EUSIS) to the Mediterranean Basin.

The creation of a georeferenced soil database for Malta and Gozo, compatible with the European Soil Bureau database, could be used to assess the sustainability of current soil use and management and to develop models for predicting potential uses and risks. At the national level, the driving force is an ever-increasing demand for harmonised and compatible soil data information by policy and decision- makers, planning regulators, environmental managers, agriculturists and civil engineers.

In comparison to other European and Mediterranean countries, the state of soil information in the Maltese Islands is relatively poor and insufficient to meet current requirements for agricultural production and sustainable use of land resources. Although at present knowledge is limited and the necessary expertise in soil information is lacking, it is a national priority to consolidate efforts towards the development of a soil information system for the Maltese Islands. Moreover, the creation of a permanent operational structure (a national soil office) would support Malta’s participation in a fully integrated Euro-Mediterranean Network of Soil Information.

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Appendix A: Supporting data

Type of map	Organisation	Area covered	Date	Scale	Remarks
Topographical maps	Public Works Department	Malta & Gozo	1968	1:2500	Available in print form
Topographical maps	Planning Authority	Malta & Gozo	1990	1:25000	Available in print and digital form
Topographical maps	Planning Authority	Malta & Gozo	1990	1:25000	Available in print and digital form
Geological maps	Department of Information	Malta & Gozo		1:25000	
Soil map	Department of Agriculture	Malta & Gozo	1960	1:31680	outdated
Permeability map	Water Services Corporation		1990	1:100,000	
Land registration (tenancy)	Department of Agriculture	Malta & Gozo	N/A		outdated
Land use (agriculture)	Department of Agriculture	Malta north (pilot area)			
Habitat data (rural)	Environmental Management Unit, Planning Authority	Selected areas			Circulation restricted

Appendix B: Soil Taxonomy of Maltese Soils

The classification of Maltese soils in accordance with the 7th approximation prior to the publication of Soil Taxonomy in 1975 places the carbonate raw soils and the San Biagio series of the xerorendzinas into the Entisol order of Soil Taxonomy. "Entisols are mineral soils with little or no evidence of pedogenetic horizons arising from a too short pedogenesis period, geomorphic instability or little weatherability of the parent materials."

Five Entisol suborders are recognised: Aquents (poorly developed wet soils), Arents (disturbed by man), Psamments (sandy), Fluvents (alluvial soils with irregular organic matter distribution in depth), and *Orthents* (other Entisols). Orthents are, by far, the most abundant Entisols in the Mediterranean region and account for the Entisols of the Maltese Islands.

Order: ***Entisol***
Suborder: ***Orthents:***
"Other Entisols."
Great Group: ***Xerorthents:***
"Other Orthents that have a xeric moisture regime."
Subgroup: ***Typic Xerorthents:***
"Other Xerorthents."
Subgroup: ***Lithic Typic Xerorthents:***

"Other Xerorthents that have a lithic contact within 50 cm of the mineral soil surface."

The remaining series within the xerorendzinas: Alcol and Tal-barrani series; together with the terra soils are classified as ***Ustochrepts***, a great group of the order ***Inceptisols***: "young, immature soils whose pedogenic features are less outstanding than in mature soils" (Torrent, 1995).

However, this great group is not present in the "Keys to Soil Taxonomy, eighth edition, 1998". The great group Ustochrepts was deleted from Soil Taxonomy in 1975 and replaced with the great group ***Xerochrepts***. The great group Xerochrepts was then deleted from Soil Taxonomy in 1998 and was replaced with the suborder of ***Xerepts***.

Order: ***Inceptisols***
Suborder: ***Xerepts:***

"Other Inceptisols that have a xeric soil moisture regime."
The Terra soils were classified as Typic Ustochrepts. With regard to the latest Soil Taxonomy, these are likely to be ***Typic Haploxerepts***.

Great Group: ***Haploxerepts:***
"Other Xerepts."
Subgroup: ***Typic Haploxerepts:***
"Other Haploxerepts."

While the Rendollic Ustochrepts (Alcol and Tal-barrani series) will likely be ***Calcixerepts*** in either the aridic or typic subgroups.

Great Group: ***Calcixerepts:***
"Other Xerepts that *both*:

Have a calcic horizon with its upper boundary within 100 cm of the mineral soil surface or a petrocalcic horizon with its upper boundary within 150 cm of the mineral soil surface; *and*

Are calcareous in all parts above the calcic or petrocalcic horizon, after the soil between the mineral soil surface and a depth of 18 cm has been mixed.

Subgroup: ***Typic Calcixerepts:***
"Other Calcixerepts."

With reference to the "Key to the FAO Soil Units" as contained in the "Legend of the Soil Map of the World" (UNESCO, Paris, 1974) the classifications are defined as follows:

Regosols:

"Other soils having no diagnostic horizons or none other than (unless buried by 50 cm or more new material) an *ochric* A horizon."

Calcaric Regosols (Rc):

"Other Regosols which are calcareous at least between 20 and 50 cm from the surface".

Vertisols (V):

"Other soils which, after the upper 20 cm are mixed, have 30 per cent or more clay in all horizons to at least 50 cm from the surface; at some period in most years have cracks at least 1 cm wide at a depth of 50 cm, unless irrigated, and have one or more of the following characteristics: gilgai microrelief, intersecting slickensides or wedge-shaped or parallelpiped structural aggregates at some depth between 25 and 100 cm from the surface".

Chromic Vertisols (Vc):

"Other Vertisols" having moist chromas of less then 1.5 dominant in the soil matrix throughout the upper 30 cm".

Chromic Vertisol sodic:

"Other Vertisols" with "an exchangeable sodium percentage (ESP) of more than 15 within 50 cm from the soil surface".

Cambisols (B):

"Other soils having a *cambic* B horizon or an *umbric* A horizon which is more than 25 cm thick."

Calcic Cambisols (Bk):

"Other Cambisols showing one or more of the following: a *calcic* horizon or a *gypsic* horizon or concentrations of soft powdery lime within 125 cm of the surface when the weighted average textural class is coarse, within 90 cm for medium textures, within 75 cm for fine textures; calcareous at least between 20 and 50 cm from the surface."

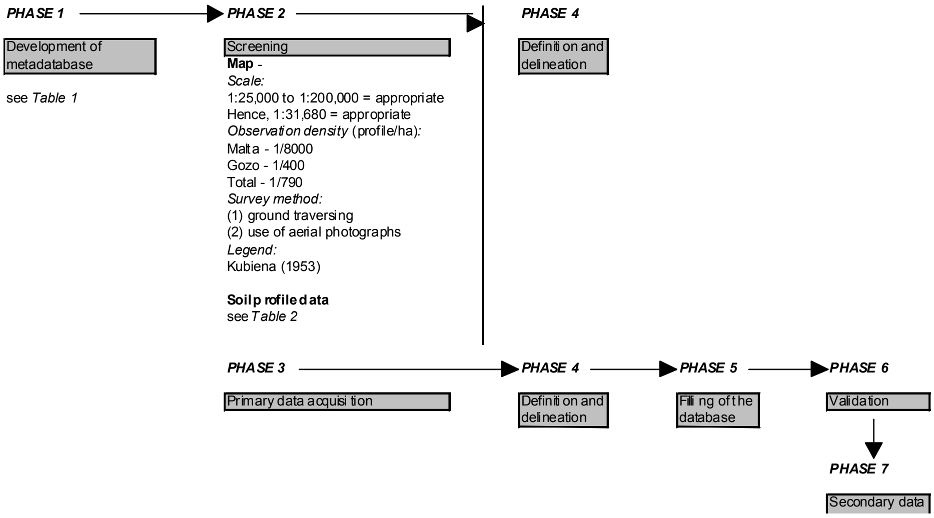
Calcic Cambisol lithic:

As above, with a "continuous hard rock within 10 cm from the soil surface".

Chromic Cambisols (Bc):

"Other Cambisols which have a strong brown to red B horizon (rubbed soil has a hue of 7.5YR and a chroma of more than 4, or a hue redder than 7.5 YR)."

Flowchart to illustrate the work to be done in a possible pilot area project in Malta for the 1:250.000 scale soil database according to the ESB Manual.



Requirements to existing soil profile data

Requirement	Status
1. The position (coordinates) of the sampling site is exactly known	
2. The data are descriptive of a whole soil profile down to the depth of 150 cm (59 in) or to the lithic contact, if shallower. They must refer to all soil horizons or lithological layers thicker than 10 cm, and include also important thinner layers (e.g. iron pans).	
3. Required attributes are the mandatory attributes described Chapter 7 (see Table 3)	
4. Attributes must be coded according to Manual (ESB, 1998)	
5. Analytical data must have been determined according to acceptable methodologies.	
6. There must be an acceptable estimate of the accuracy of the data provided by the owner.	
7. The sampling sites fit to the definition and are representative of the soil body as described by the Manual and can be assigned to it.	
8. There must be a minimum of 2 sampling sites for each soil body.	
9. Data in electronic bases and GIS will be preferable.	
10. Time dependent data must be valid otherwise redetermined.	
11. The data must be reproducible. Checks must be conducted regularly on the data of the national laborities by a designated laboratory.	

Legend
Mandatory
Optional