

**STATE OF THE ENVIRONMENT REPORT**  
**2005**

**Sub-report 5:**  
**Soil**



Malta Environment & Planning Authority  
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## Soil

### Key messages

- Maltese soils can be significantly fertile and productive despite limiting natural geographical and climatic factors such as shallow depth and low levels of organic matter.
- Society underestimates the value of Maltese soil resources, in particular their ability to perform a multitude of vital functions, including food production, storage and filtering of water, and supporting human activity and biological diversity.
- Malta's principal soil contamination sources include point sources such as quarries, industrial facilities and waste dumps, and diffuse pollution from aerial deposition of dust or combustion products, exhaust emissions, lead shot, agricultural chemicals and application of manure and compost.
- As a result of pressures from high population density and certain agricultural practices, Maltese soils' vulnerability to erosion by water, salt and nutrient loading and localised contamination have been intensified. This increases the threat of long-term land degradation.
- A wide variety of organisms live in the soil and the reduction of soil biodiversity makes it more susceptible to other degradation processes.

### 5.1 Maltese Soils

Soil<sup>129</sup> is one of the basic components of life on earth. It has taken thousands of years for it to develop into the resource necessary for agriculture and horticulture.

**Soils contribute to maintaining the countryside as well as natural and semi-natural vegetation, supporting millions of fauna, including organisms that break down plant debris, managing water quality and distribution, preserving the earth's archaeological heritage, and managing potential pollutants such as artificial pesticides and fertilisers. Sadly, too many people view soils as an unlimited resource, while in fact soil is easily destroyed if it is misused. However given proper management, soil can continue to serve the needs of humans and other living beings for the foreseeable future.**

The spatial pattern of Maltese soil types is very intricate, both in semi-natural and agricultural areas. Different soil types often occur within a single field or within a distance of a few metres. Three closely inter-related human factors have contributed to this complexity: the movement of excavated soil material from construction sites in accordance to the Fertile Soil Act,<sup>130</sup> the creation of 'made ground' or replenishment of eroded or shallow soils, and the impacts of

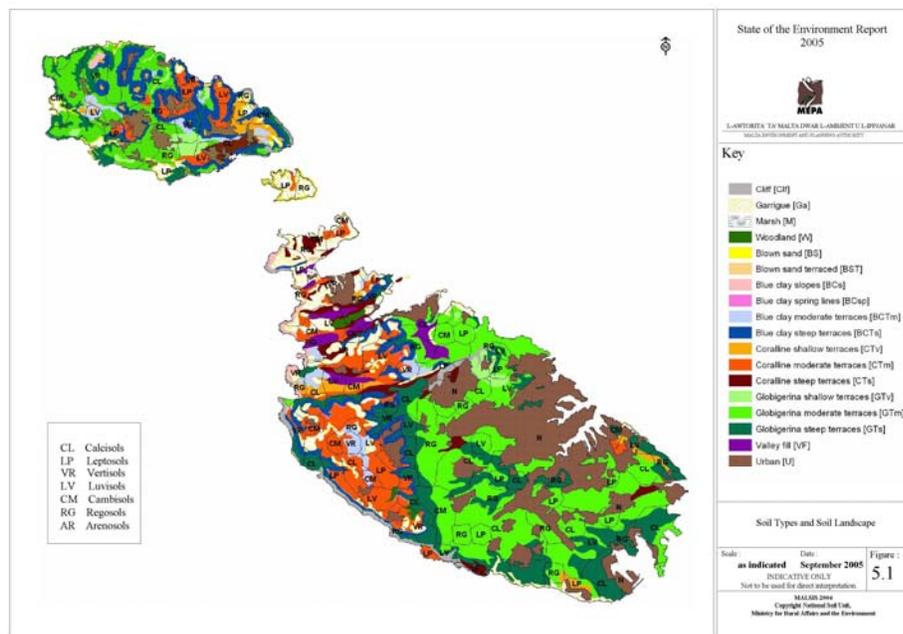
<sup>129</sup> This chapter is based on Sammut (2005).

<sup>130</sup> Fertile Soil (Preservation) Act (Act XXIX of 1973) (Cap 236).

urbanisation. Nevertheless, during 2004 a soil classification was developed on the basis of a recent national soil inventory and other sources on specific issues.<sup>131</sup>

### Classification

Different soils form on different types of landscapes. Malta's semi-natural landscapes, which human activity such as intensive grazing or woodland clearance may have contributed to the formation of, comprise bare sea cliffs, garrigue, marsh, woodland, Blue Clay slopes, Blue Clay spring line, and blown sand. In other rural landscapes human influence is evident in the widespread terracing of sloping land, and the creation of made ground through the movement of large quantities of soil material and deposition on rock or rock rubble. These landscapes include moderate or steep terraces on Blue Clay, shallow, moderate or steep terraces on Coralline limestone, shallow, moderate or steep terraces on Globigerina limestone, valley fill and terraced blown sand (see Map 5.1). Malta's seven major soil types and their characteristics<sup>132</sup> are listed in Table 5.1.



Source: MRAE

**Map 5.1: Soil landscapes and soil types of the Maltese Islands**

<sup>131</sup> These include salinity (Sivarajasingham 1971, Vella and Camilleri 2003), trace nutrients (Silanpaa 1982, Camilleri 2000, and Cauchi 1999), heavy metals (Vella 1997, Wasteserv 2004), soil biodiversity (Stevens 2005), soil erosion (Tanti *et al.* 2002), soil-water characteristics (Mitschoff 1991) and soil mapping (Vella 2000, Vella 2001 and Vella 2003).

<sup>132</sup> MAL SIS 2004.

Soil Type	Distribution (as % of country area)	Characteristics
Calcisols	27%	Calcisols are lime-rich soils with significant accumulation of secondary calcium carbonates, generally developed in dry areas. Dryness, and in places also stoniness, limit the suitability of these soils for agriculture, however, if irrigated, drained, and fertilised, calcisols can be highly productive under a wide variety of crops.
Leptosols	13 %	These are shallow soils over rock or gravel, the development of which is often limited by erosion. Shallowness affects cropping by influencing the range and type of cultivation that can be carried out but also by restricting nutrient uptake, root growth and, in the case of fruit trees, root anchorage. In Malta, these soils include the 'soil pockets' formed on karst landscape.
Vertisols	8 %	These heavy cracking clays are found on Blue Clay. The deep sandy soils developed in recently deposited sandy beaches are mostly vulnerable to soil degradation, especially if not managed sustainably. These soils in particular deserve formal protection.
Luvisols	13 %	Luvisols are soils with a subsurface layer of high-activity reddish clay accumulation. They are normally fertile soils suitable for a wide range of uses, but certain types require artificial internal drainage and careful timing of cultivations.
Cambisols	5 %	Cambisols are soils with incipient soil formation. They are usually medium-textured and have a good structural stability, high porosity, good water holding capacity and good internal drainage. Cambisols make good agricultural land and are usually intensively used.
Regosols	14 %	Regosols are very weakly developed mineral soils in unconsolidated material. They are usually the 'rest' group, holding soils that do not belong to other groups.
Arenosols	Not determined; found only in localised areas	Arenosols consist of sandy soils that develop in residual sands <i>in situ</i> after weathering of old, usually quartz-rich material or rock, and soils developed in recently deposited sands as occur in deserts and beach lands. In the Maltese Islands, this type of soil is present in sand dunes (for example at Ramla and Armier).

Source: *MALSIS 2004*

**Table 5.1 Maltese soil types**

## 5.2 Soil Quality

Soil quality assessment involves measurement of the state of the soil, and includes social judgments regarding suitability made on the basis of fitness for use, as well as accepted standards. Maltese soils range between slightly and moderately alkaline (with pH values between 7.3 and 8.5).<sup>133</sup> They are of moderate soil density so that density-induced impedance to root growth is minimal. In deeper soils (> 50 cm), heavy clay soils are the densest. Clay contents of higher than 48 percent are found in 77 percent of Maltese soils: such soils may be difficult to work, but have higher nutrient retention and water filtration capacities. In general, the soils are non-saline (having a mean electrical conductivity of 347  $\mu\text{S}/\text{cm}$ ), however, in irrigated soils, the electrical conductivity is significantly higher (695  $\mu\text{S}/\text{cm}$ ). This suggests that although with the exception of some sub-types, most soils do not have salt-related problems, irrigation with poor quality water, especially saline

<sup>133</sup> MALSIS 2004.

treated sewage effluent, is increasing soil salinity (see discussion below on soil salinity).

The soils' suitability for agriculture is limited by a number of factors, the most important of which include: unfavourable soil chemical status as a result of alkalinity and the calcareous nature of the soils; shallow depth; low soil organic matter; high soil stoniness; droughty conditions for long periods of time; and, low water absorption rates due to impermeable surface crusts. Soils with a carbonate and bicarbonate content greater than 25 percent occupy approximately 91 percent of the total country area.<sup>134</sup> In the Maltese Islands, very shallow soils (< 25 cm) and shallow soils (> 25 cm and < 50 cm) occupy 58 percent of the country's area. 40 percent of soils are estimated to contain more than 15 percent coarse fragments. **Nevertheless, as indicated by statistics on locally produced agricultural products,<sup>135</sup> Maltese soils can be significantly fertile and productive despite their limitations due to natural geographical and climatic factors.**

Soil quality may also be assessed on the basis of key quality parameters, as presented in Table 5.2 below. Other important quality indicators, for which data is not available are Olsen Phosphorous (plant available phosphorous), sediment load to water courses and soil erosion loss/loss of soil functions. It would also be useful to monitor soil salinisation, field sediment loss by type of cultivation, as well as to construct a soil moisture budget.

<b>Soil organic matter</b>	Soil organic matter influences most soil functions, and is a key determinant of the soil's productivity. It is widely believed that a major threshold is 2 percent soil organic carbon, below which potentially serious decline in soil quality will occur. It has been estimated that 46 percent of the soils in Malta are low (1-2 percent) or very low (<1 percent) in organic carbon, and 50 percent have a medium content (2-6 percent) <sup>136</sup> (see Map 5.2).
<b>Area of land lost to urbanisation and development</b>	This contributes significantly to loss of soil. During the past 30 years, 4,462 ha of agricultural land were lost to development. The average annual rate of loss of land decreased by 61 percent from 213 ha per annum for the period 1971 to 1986 to 84 ha per annum for 1986 to 2001. <sup>137</sup>
<b>Heavy metal concentrations in soils</b>	This is an indicator of soil contamination, which leads in this case to loss of soil functions, i.e. the ability to support plant life. Baseline data indicates that in 25 percent of Maltese soils, the concentration of lead exceeds the limit (100 mg/kg) for the application of sewage sludge. Seven percent of soils exceed the 200 mg/kg limit established for zinc, and in three percent of the soils, the 100 mg Cu/kg threshold for copper is exceeded. Map 5.3 shows the extent of soils where the concentration of heavy metals exceeds the legal limits <sup>138</sup> for the application of sludge.

Source: *MALSIS 2004*

**Table 5.2 Soil quality indicators**

<sup>134</sup> MALSIS 2004.

<sup>135</sup> NSO 2004.

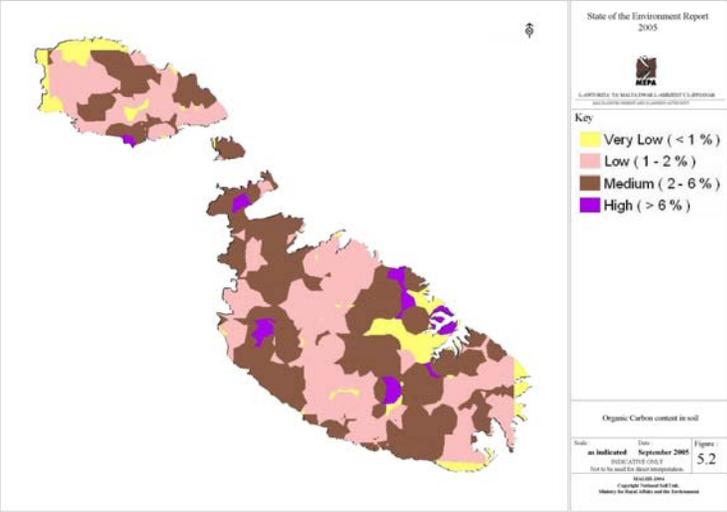
<sup>136</sup> MALSIS 2004.

<sup>137</sup> MEPA 2003.

<sup>138</sup> Stipulated in the Sewage Sludge regulations (LN 212 of 2001).

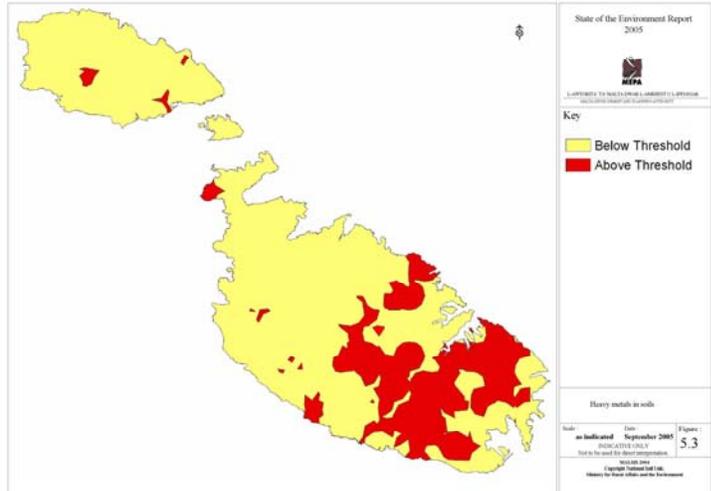
Source: MRAE

**Map 5.2:  
Organic  
carbon  
content of  
Maltese soils**



Source: MRAE

**Map 5.3: Soils  
with  
concentrations  
of heavy  
metals  
exceeding the  
limits of the  
Sewage  
Sludge  
Regulations**



*Soil biodiversity*

Soil provides an important supporting medium for millions of living organisms. Soil flora and fauna have a fundamental role in cycles that enable the soil to support natural and semi-natural vegetation without additions of fertiliser and other support mechanisms. They break down plant debris, take in gases from the air and aerate the soil, together with many other functions. As many as 600 million bacteria belonging to up to 20,000 species may be contained in 1 gram of healthy soil.<sup>139</sup> Even a similar amount of apparently barren desert soils can contain 1 million bacteria from up to 8,000 species. As well as those soil organisms that spend their whole life in the soil, there are also larger organisms that depend on the soil for important parts of their daily life, such as rabbits and reptiles, but also

139 CEC 2002.

birds, some of which nest on its surface while others nest in burrows in the soil. Many birds rely on soil for food supply and including vegetation growing in the soil. **A wide variety of organisms live in the soil and the reduction of soil biodiversity makes it more susceptible to other degradation processes.**

Data on soil macro and micro fauna and flora in Malta is incomplete, and information available is limited to selected group of insects, molluscs, fungi (mostly mushrooms and some plant pathogens) and some invertebrate species associated with leaf litter, particularly in wooded areas. This brief review<sup>140</sup> is restricted to soils not used for agriculture. In this context, important habitat types in terms of soil biodiversity include woodlands of various types, argillaceous soils (clay slopes) and karst soil pockets in garrigue, rocky steppes and cliffs (*rdum*). These contain threatened and endemic species such as the endemic door-snail *Lampedusa imitatrix*.<sup>141</sup>

Fungi are found in soils in wooded areas and garrigue and are generally not visible to the naked eye except during the fruiting period of macrofungi, which produce various fruiting bodies, popularly known as 'mushrooms'. Examples include the ovoid grisette *Amanita ovoidea*,<sup>142</sup> the red basket or cage fungus *Colus hirudinosus*,<sup>143</sup> the white morsel *Helvella crispa*, the very rare blushing wax-cap *Hygrocybe ovina* and the blood milk-cap *Lactarius sanguifluus*.<sup>144</sup>

The soil present in shallow rock basins (*kamenitzae*) in karstic environments is also important for its biodiversity. These karstic structures in coralline limestone fill with freshwater during the wet season forming temporary rock pools (*ghadajjar fil-blat*). Since the pools are temporary, flora and fauna are ephemeral, growing rapidly and capable of reproducing in the limited time available. Such flora and fauna persist from one cycle to another as seeds, eggs or cysts in the shallow soil layer in the karstic structure that eventually fills with water. Species thriving in such resting stages in the soil include the Maltese waterwort (*Elatine gussonei*),<sup>145</sup> the Mediterranean star-fruit (*Damasonium bourgaei*) and the tadpole shrimp (*Triops cancriformis*), one of the oldest species inhabiting this planet.

Specialised habitats, such as saline marshlands, freshwater wetlands and other humid areas, also include important soil-dependant species. A few examples include the endemic beetle *Otiorhynchus ovatulus*,<sup>146</sup> the woodlouse *Spelaeoniscus*

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<sup>140</sup> Based on Stevens 2005.

<sup>141</sup> Giusti *et al.* 1995.

<sup>142</sup> Briffa and Lanfranco 1986.

<sup>143</sup> Lanfranco 1989.

<sup>144</sup> Briffa and Lanfranco 1986.

<sup>145</sup> Brullo *et al.* 1988.

<sup>146</sup> Magnano 1993.

*vallettai*,<sup>147</sup> and the endangered dune beetle *Xanthomus pallidus*.<sup>148</sup> A number of soil-inhabiting species have been found in soil at 10-30 cm depth, often under trees, many of which have been recently described as new species to science, and are endemic to the Maltese Islands. A couple of examples include the endemic weevil (*Alaocyba melitensis*), and a deep-burrowing slug (*Testacella riedel*).<sup>149</sup>

### 5.3 Threats to Maltese soils

Soil is under increasing threat from a wide range of human activities, which are undermining its long-term availability and viability. In Malta, increases in urbanisation and development, and certain agricultural practices, have accentuated pressures on land. Maltese soils are threatened by many of the threats identified internationally: erosion, decline in organic matter, soil contamination (local and diffuse), soil sealing, soil compaction, decline in soil biodiversity, salinisation, and flood and landslides.<sup>150</sup> **As a result of these pressures, Maltese soils' vulnerability to erosion by water, salt and nutrient loading and localised contamination have been intensified. This increases the threat of long-term land degradation.** There is limited data on the extent and severity of each threat for Malta, and on the economic and environmental implications of soil degradation, however it is considered that the five major threats to Maltese soils are erosion, sealing (through land uptake), decline in organic matter, soil contamination, and salinisation.

#### *Soil erosion*

Although data on rates of soil erosion in Malta are not available, this phenomenon is believed to be one of the most important threats to soil in the country. Soil erosion is caused by both climatic and anthropogenic factors. Soil is eroded by wind and water, while human activities such as land development, quarrying, waste disposal, overexploitation of freshwater resources, deforestation, overgrazing, down slope ploughing, and land abandonment directly remove soil or degrade the soil leading to soil erosion.<sup>151</sup>

National policies and agri-environmental measures under the Rural Development Plan<sup>152</sup> have been directed to the reduction of soil erosion processes and mitigation of damage, and are linked to the preservation of retaining rubble walls, since these structures are considered to prevent soil erosion from terraced fields.<sup>153</sup> The area

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<sup>147</sup> Caruso and Lombardo 1982.

<sup>148</sup> Mifsud 1999.

<sup>149</sup> Maltese and common names have not yet been allocated to these species.

<sup>150</sup> CEC 2002.

<sup>151</sup> Tanti *et al.* 2002.

<sup>152</sup> RDD-MRAE 2004.

<sup>153</sup> See also Sub-report 6 on Landscape.

of damaged terraced retaining rubble walls supported through the agri-environment measure of the Rural Development Plan was approximately 150,000 m<sup>2</sup>. Land tenure also plays a part in rubble wall maintenance. The Agricultural Leases (Reletting) Act, 1967 (Cap 199) sought to address this but has not managed to stem the damage. The rubble walling is protected under the Rubble Walls and Rural Structures (Conservation and Maintenance) Regulations, but most of the arable land in the Maltese Islands remains severely to moderately eroded due to poor wall maintenance. The Building Industry Consultative Council organises training courses in rubble wall construction.

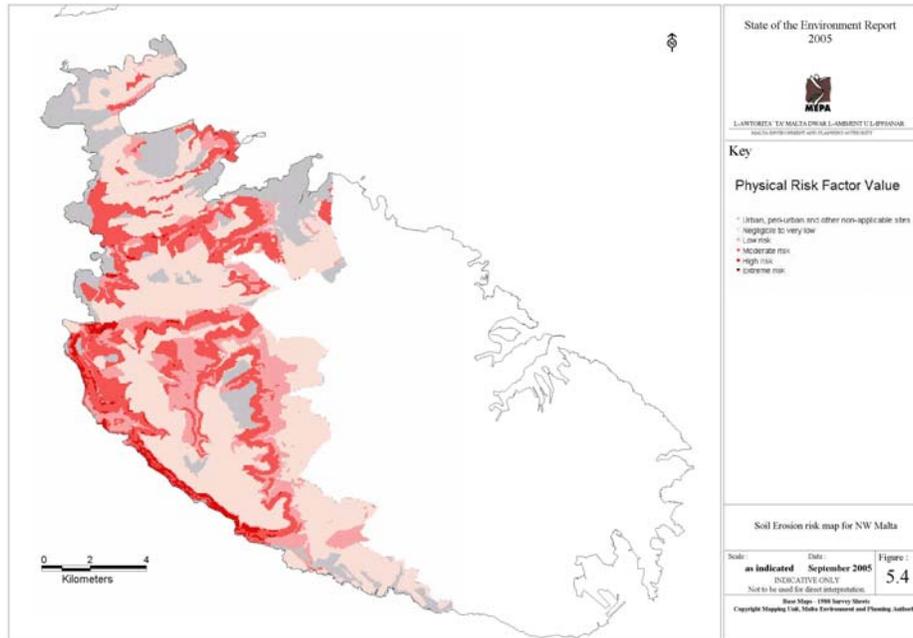
Malta ratified the United Nations Convention to Combat Desertification in 1998, which the European Community has also adopted through Council Decision 98/216/EC. The Convention's objectives are to combat desertification, understood as the end result of land degradation processes, and mitigate the effects of drought through developing policies and taking action at all levels. This is supported by international cooperation and partnership arrangements in the framework of an integrated approach. Further specific provisions are laid down in the five regional implementation annexes, and Malta, as an affected country, forms part of the Northern Mediterranean Region (Annex IV).

#### **Box 5.1 The CAMP Malta project**

Part of the MAP CAMP Project for Malta<sup>154</sup> addressed urgent land degradation processes that are resulting in significant negative impacts on the environment, biodiversity, socio-economic conditions and agricultural potential of the Maltese Islands. Mapping activities at different levels (Northwest and pilot area), and the identification and assessment of physical parameters and processes of erosion were carried out. The integration of these outputs with socio-economic factors led to the identification of priority areas for immediate intervention based upon soil erosion risk. A risk map for Northwest Malta was prepared by the overlaying of geological features, soil protection management practices, status of terraces/retaining rubble walls, and land use. Four main risk areas were identified - clay slopes, linked with poorly maintained retaining rubble walls; steep slopes; valley beds/flood prone areas; and, areas under the influence of runoff water from non-absorbent sealed surfaces such as roads and buildings (see Map 5.4). The state of maintenance and the number and length of breaches of rubble walls were used as indicators for soil erosion risk. Two case studies, conducted at Tas-Santi valley, I/o Mgarr and Burmarrad plains, both in the Northwest of Malta, indicate that the length of breached retaining walls was found to be 7 percent and 15 percent of total wall length respectively. The CAMP Malta project identified the maintenance of retaining walls as a priority issue for the environmental management of Northwest Malta.

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<sup>154</sup> Tanti *et al.* 2002.



Source: Tanti et al. 2002

**Map 5.4: Physical erosion risk in Northwest Malta**

#### *Soil sealing*

Soil sealing refers to the irreversible covering of soil for housing, roads, or other land development, as well as for concreted countryside areas such as livestock farms, certain greenhouses for horticulture, and recreational areas. The threat of soil sealing, which results in loss of soil functions or direct soil loss, as well as increasing the risk of soil erosion by run-off waters in adjacent areas, is most serious on a European level in the built-up coastal areas of the Mediterranean.<sup>155</sup> In Malta, where approximately 23 percent of the total land area is currently urbanised,<sup>156</sup> the threat is also pronounced. Despite the fact that soil sealing is prohibited,<sup>157</sup> and no person may cover fertile soil with any layer of concrete, stones or stone slabs, in practice this legislation is difficult to enforce and has in itself contributed to considerable mixing of soil as a result of soil stripping and deposition in alternative sites. Although not as significant a threat in the Malta context as soil sealing, soil compaction also increases the risk of soil erosion due to increased rate of flow and volume of surface water run-off. Soil compaction arises from activities such as using fields for vehicle parking, off-roading, intensive and/or continuous trampling, and the practice of compacting fields for use in bird trapping.

155 CEC 2002.

156 [http://cdr.eionet.eu.int/mt/eea/colgaaccw/copy\\_of\\_envqaacua/Data\\_request\\_soil\\_sealing\\_2004\\_MT](http://cdr.eionet.eu.int/mt/eea/colgaaccw/copy_of_envqaacua/Data_request_soil_sealing_2004_MT)

157 Fertile Soil (Preservation) Act (Act XXIX of 1973), amended in 1983.

### *Decline in organic matter*

Decline in organic matter as a result of intensive cultivation has become a major driver of land degradation, and again, on a European level, affects mainly the countries of southern Europe.<sup>158</sup> In Malta, long-term data is not available to assess whether organic matter has declined, however, baseline measurements conducted in 2002-2003<sup>159</sup> indicate that 46 percent of the land has a surface soil horizon that contains less than 2 percent organic carbon (3.4 percent of organic matter).

### *Soil contamination*

The occurrence of high levels of contaminants in soils has multiple negative consequences for the food chain, and thus for human health, as well as for all types of ecosystems and other natural resources. **Point source contamination is generally associated with mining, industrial facilities, waste dumps and other facilities, both in operation and after closure.** In Malta, a comprehensive soil contamination assessment has not yet been carried out, and existing data is limited to heavy metals and to 'hot spot' areas.

Former waste dump sites, in particular the former waste dump site at Magħtab, are significant point sources for soil contamination in Malta. The Scott Wilson report,<sup>160</sup> indicates that soils in the immediate vicinity of the Magħtab dump show concentrations of lead, total phenols and dioxins that exceed background levels.<sup>161</sup> Other potential sources of lead contamination in the environment include aerial deposition of dust or combustion products, aerial deposition of vehicular exhaust emissions from nearby roads, and lead shot from hunting.

**Important sources of diffuse contamination by heavy metals include the application of livestock manures, compost from mixed municipal waste, agricultural chemicals, and treated sewage effluent to agricultural land.**

Production systems where a balance between farm inputs and outputs is not achieved lead to nutrient imbalances in soil and frequently result in soil nutrient loading (eutrophication) as well as contamination of ground and surface waters. Assessments of nutrient balances conducted for selected intensive farming systems in Malta indicate a net excess of nutrients that has the potential to accumulate in soil or be lost to the environment, particularly water bodies. The accumulation of pesticides in soils is also a potential source of soil contamination; however no data is yet available on this matter.

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<sup>158</sup> CEC 2002.  
<sup>159</sup> MALSIS 2004.  
<sup>160</sup> WasteServ Malta 2004.  
<sup>161</sup> See also Section 9.2 in Waste Sub-report.

### *Salinisation*

Salinisation refers to the accumulation in soils of soluble salts, to the extent that soil fertility is reduced, and it is often associated with irrigation in regions with low rainfall and high water evaporation rates. Apart from one-time measurements, soil salinity monitoring data does not exist and salinisation is poorly documented in Malta. In irrigated areas the soil electrical conductivity (a measure of total soluble salts) is up to twice as high as that in non-irrigated regions, and losses in yields are often reported.

The EU 6<sup>th</sup> Environment Action Programme<sup>162</sup> defines soil as a finite resource and advocates its sustainable use. Accordingly, the proposed EU Thematic Strategy<sup>163</sup> and the upcoming Framework Directive for the protection of soil will include guidelines and minimum standards for the identification of risks and mitigation measures. This initiative is not however intended to replace good national practices, so it is important that a national strategy for soil protection in Malta is established and recognised as the basis for action.

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<sup>162</sup> CEC 2001.  
<sup>163</sup> COM (2002) 179 final.

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