Marine Acidification

1.1 Introduction

Oceans act as natural sinks of carbon dioxide (CO_2) emissions through uptake of this gas from the atmosphere. Although oceanic uptake of CO_2 reduces the extent of global warming as result of increased anthropogenic CO_2 emissions, this process is resulting in perturbation to the oceans' carbonate systems and increasing the ocean's acidity, a process known as 'marine acidification'.

Marine acidification is directly linked to anthropogenic emissions of CO_2, with average surface ocean pH known to have decreased by approximately 0.1 pH unit[1,2] since the beginning of the industrial era. Based on emission scenarios developed by the Intergovernmental Panel on Climate Change (IPCC), average surface ocean pH could decrease by 0.3-0.4 pH units from pre-industrial values by end of this century[3].

Increased uptake of CO_2 reduces the availability of carbonate ions (CO_3^{2-}) in seawater which are used by calcifying organisms, such as corals, molluscs, echinoderms and crustaceans, to produce their calcareous shells and skeletons. Marine acidification can thus impact on calcifying organisms, by affecting calcification rates. Physiological processes other than calcification are also known to be adversely affected by marine acidification as described in Fabry *et al*. (2008)[4]. Such effects at species level can result in changes to biodiversity, trophic interactions and other ecosystem processes[5]. Impacts of marine acidification however are still poorly understood and further research is necessary to define and quantify the effects of such process on marine biota and ecosystem functions.

The EU Marine Strategy Framework Directive calls for assessment of 'pH, pCO_2 profiles or equivalent information used to measure marine acidification' as per Annex III of the Directive. Within this context, the first reporting cycle of the MSFD calls for an initial assessment of the marine acidification process, mainly on the basis of pH data.

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[1] Touratier, F.; Guglielmi, V., Goyet, C., Prieur, L.; Pujo-Pay, M.; Conan, P. & Falco, C. 2012 Distributiona of the carbonate system properties, anthropogenic CO2 and acidification during the 2008 BOUM cruise. Biogeosciences Discussions **9**: 2709-2753

[2] Fabry, V.J.; Seibel, B.A.; Feely, R.A. & Orr, J.C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes – ICES Journal of Marine Science, **65**: 414-432

[3] Fabry, V.J.; Seibel, B.A.; Feely, R.A. & Orr, J.C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes – ICES Journal of Marine Science, **65**: 414-432

[4] Fabry, V.J.; Seibel, B.A.; Feely, R.A. & Orr, J.C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes – ICES Journal of Marine Science, **65**: 414-432

[5] Fabry, V.J.; Seibel, B.A.; Feely, R.A. & Orr, J.C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes – ICES Journal of Marine Science, **65**: 414-432

1.2 Existing legislation

Marine acidification is a result of anthropogenic emissions of CO_2 which is the main greenhouse gas responsible for global warming and climate change. Climate change legislation is thus deemed of relevance in addressing this pressure in the marine environment. This section provides a brief description of the main legislative tools on climate change.

1.2.1 United Nations Framework Convention on Climate Change (UNFCCC)

Malta ratified the United Nations Framework Convention in 1994 as a non-Annex I country. The ultimate objective of the Convention is to stabilize greenhouse gas concentrations '*at a level that would prevent dangerous anthropogenic interference with the climate system, which level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner*'.

Linked to this Convention is the Kyoto Protocol which is an international agreement setting internationally binding emission targets. Malta ratified this protocol as a non-Annex I country and thus has no emission limitation or reduction targets for greenhouse gases (GHG) for the first commitment period.

In 2009, Malta made a request for its inclusion in Annex I to the UNFCCC, which request was adopted in 2010. Malta is now included in Annex I but still remains without quantified emissions limitation or a reduction target for the first commitment period of the Kyoto Protocol between 2008-2012.

1.2.2 EU Policy on Climate Change

The EU climate and energy package sets climate and energy targets for 2020 known as the "20-20-20" targets:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

These targets should be delivered through the implementation of complementary pieces of legislation, including:

- The EU Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (EU ETS) aimed at promoting reductions of greenhouse gas emissions in a cost-effective and economically efficient manner. This Directive introduces a single EU-wide cap on emission allowances. Annex I lists categories of activities to which this Directive applies. In Malta, only emissions of CO_2 from the two power plants fall within the scope of the Directive[6].
- The Effort Sharing Decision (Decision 406/2009/EC) establishes binding annual greenhouse gas emission targets for sectors not covered by the EU ETS. Malta is bound to limit GHG emissions from these sectors to a maximum of +5% of 2005 levels by 2020[7].
- The Renewable Energy Directive (2009/28/EC) calls for the need for Member States to set targets for raising the share of renewable energy in their energy consumption. These targets, which reflect Member States' different starting points and potential for increasing renewable production, range from 10% in Malta to 49% in Sweden.

1.3 Carbon Dioxide Emissions in Malta

The National Annual Greenhouse Gas Emissions Report for Malta (2013)[8], a submission under the United Nations Framework Convention on Climate Change, provides an inventory of total Greenhouse Gas Emissions at a local scale. CO_2 emissions account for approximately 87.2% share of total gross emissions in 2011. The report also indicates an overall increase in emissions in the period 1990-2011 with an increase of 44% in CO_2 emissions (Figure 1). Some level of stabilisation and decline can however be observed in the more recent years.

The Energy generation sector, represented by two power plants in Malta is the largest contributor to (overall) Greenhouse Gas emissions, followed by transport (including road transport, national navigation and domestic aviation).

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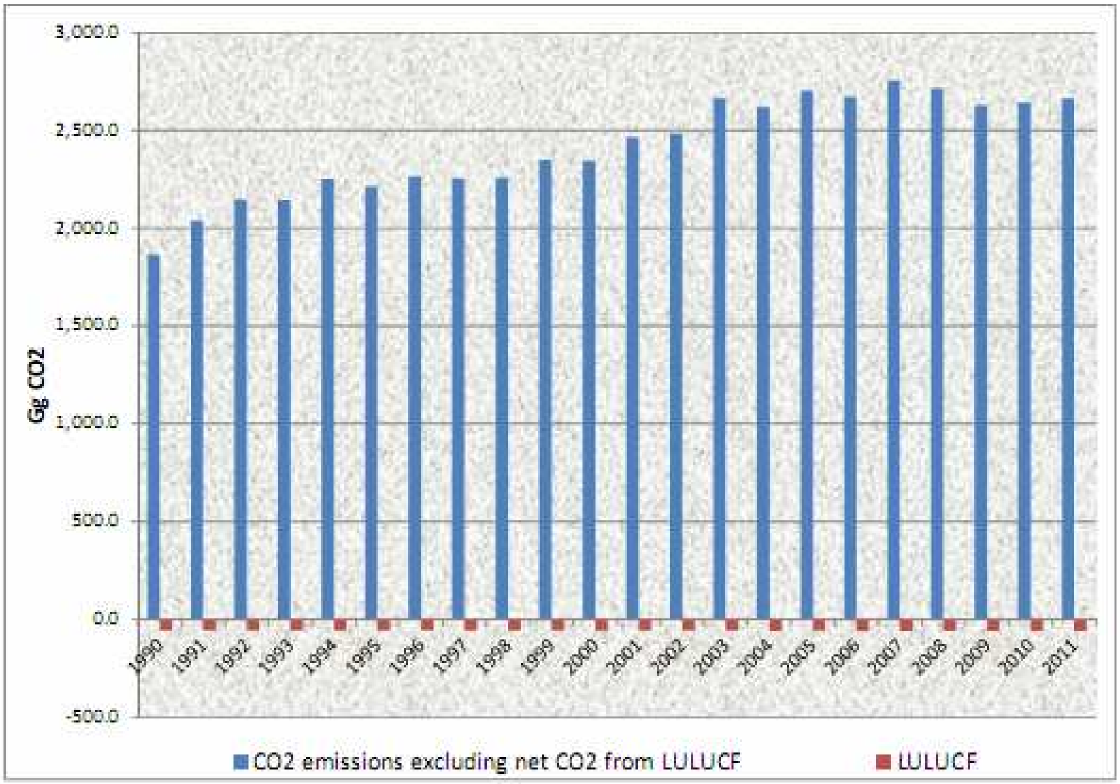
[6] Malta Resources Authority. 2013. National Greenhouse Gas Emissions Inventory for Malta 2013 - Annual Report for Submission under the United Nations Framework Convention on Climate Change. Report 4/2013

[7] Malta Resources Authority. 2013. National Greenhouse Gas Emissions Inventory for Malta 2013 - Annual Report for Submission under the United Nations Framework Convention on Climate Change. Report 4/2013

[8] Malta Resources Authority. 2013. National Greenhouse Gas Emissions Inventory for Malta 2013 - Annual Report for Submission under the United Nations Framework Convention on Climate Change. Report 4/2013

Figure 1: Trends in carbon dioxide emissions in the period 1990-2011 as extracted from Malta Resources Authority (2013)[9]



1.4 Seawater pH

The marine acidification process has not been specifically assessed in Malta and relevant data is only available with respect to pH of seawater.

pH data was collected as part of a coastal water quality monitoring programme initiated in February 1998 up to 2004[10]. This monitoring programme included the measurements of various water parameters at 9, 3 and 22 stations in Gozo, Comino and Malta respectively. The fourth report of such monitoring programme, reporting on data collected in 2000 (June, October, November), 2001 (March, April, August) and 2002 (January, February), indicated that the pH for all stations did not vary significantly from station to station or from survey to survey. pH generally ranged from 7.8-8.5.

9 Malta Resources Authority. 2013. National Greenhouse Gas Emissions Inventory for Malta 2013 - Annual Report for Submission under the United Nations Framework Convention on Climate Change. Report 4/2013

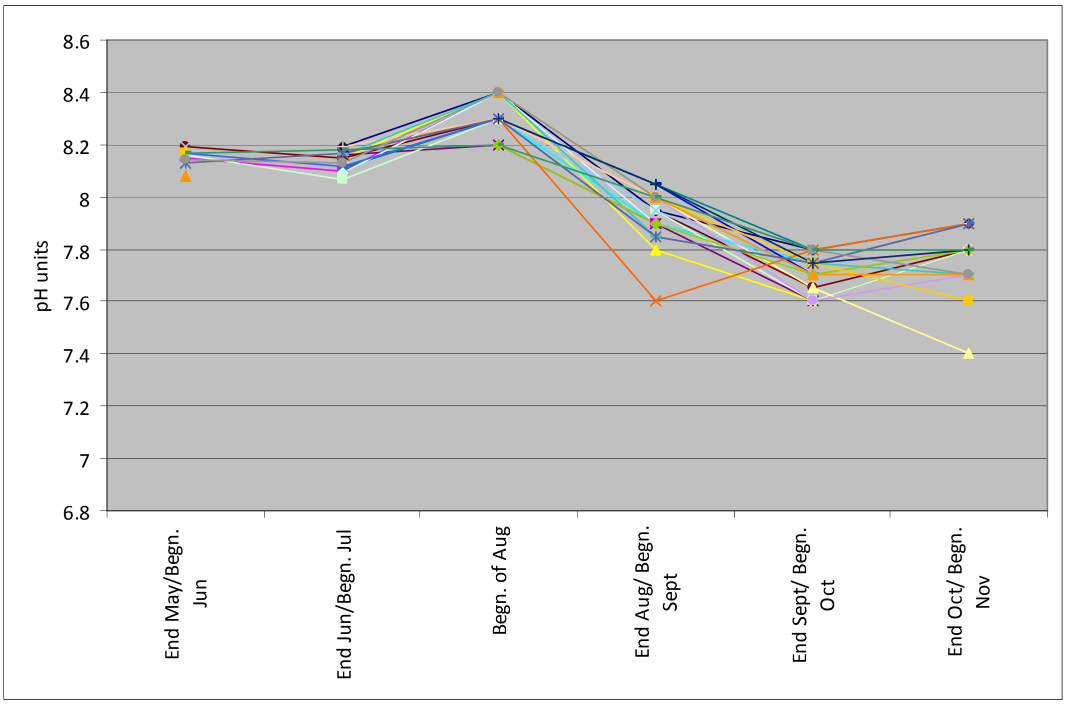
10 Axiak, V. 2000-2004 Marine Coastal Monitoring Programme; https://www.mepa.org.mt/topics-water-monitoring

This monitoring programme was discontinued in the more recent years and the most recent pH data is that collected as part of the EU Water Framework Directive baseline surveys undertaken in 26 stations within WFD coastal water bodies during the period May-November 2012[11].

In line with observations made by Axiak (2000, 2001), pH did not vary significantly across stations. Mean pH calculated for each station for the period May-November 2012 ranges between 7.84-8.05 with a minimum value across all samples of 7.6 and a maximum value of 8.4. pH seems to vary seasonally, with highest values measured in the beginning of August with a steady decrease till November.

Given the lack of continuous long term trend data in pH, further interpretation of the data available is not possible at this stage.

Figure 2: pH measured for 26 stations in the period May-November 2012[12]



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[11] CIBM and Ambiente SC. 2013. Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys – Water Lot 3 – Surveys of Coastal Water – November 2012. ERDF156 - Developing national environmental monitoring infrastructure and capacity

[12] CIBM and Ambiente SC. 2013. Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys – Water Lot 3 – Surveys of Coastal Water – November 2012. ERDF156 - Developing national environmental monitoring infrastructure and capacity

1.5 Data gaps

Significant data gaps are in relation to long-term trend data on pH. Although past data is available for inshore waters, the monitoring programme collecting such data was discontinued in more recent years. Such gaps could be addressed through the implementation of sustained monitoring programmes.

Data gaps are also in relation to the actual processes and impacts (if any) related to marine acidification in the marine environment. Further research would be required in this regard.