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Biological Phosphorus Harvesting for Multiple Uses - A New Scientific Vision

Abstract

Phosphorus (P) an important food and nutritional element for animals and nutrient for vegetation plants, known since long back, was dealt with in this study with regard to method of its harnessing from the rare renewable natural resource and bringing to variety of uses. Methods were devised for biological phosphorus harvesting from the birds feeding on the aquatic ecosystems secondary consumers such as insects, flees, mosquitoes and fish fingerlings. The study substantiated availability potential of the P by using long time (more than seven decades before) published academically accepted data. The measures developed for the harvesting of the biological phosphorous are fact based, feasible and sure to successfully work for the purpose intended for. The study opens terrestrial and terrestrial cum aquatic systems of ongoing fisheries and different birds rearing viz poultry, duck and aquatic bird rearing and harnessing their droppings in this domain are also presented. There is scope for up-scaling of this research for further exploration of Iodine (I), another important nutrient derived from sea and ocean ecosystem and customization in the local domain.

Keywords: Aquatic ecosystem, Bird droppings, Biological harvestings, Fluorescent dye, Guano, Nutrition, Nutrient, Phosphorus

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RC Yadav
Department of Water Resources and Irrigation Engineering, Madawalabu University, Ethiopia

Correspondence: R. C. Yadav, Department of Water Resources and Irrigation Engineering, Institute of Technology, Madawalabu University, South- West Ethiopia, Email ramcyadav@rediffmail.com

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Introduction

Phosphorus (P) is a while waxy non-metallic element, in the periodic table classed in group 15 and period 3 after N and preceding Arsenic As. Chemically, phosphorous has atomic weight 31, valence 5- and equivalent weight 6. Detailed discovery, forms, reaction, types and chemical properties of phosphorus is described by Horobin.[1] Phosphorus not only ignites in air but it glows in the dark because of cheluminescence oxidation process. Phosphorus is the second abundant mineral in human body in every tissue and cell, generally as salt or ester of mono, di and tri basic phosphoric acid. Phosphorus is involved in wide variety of metabolic functions eg. carbohydrate metabolism and oxidative phosphorylation, which are required to drive many metabolic processes such as active transport, muscle contraction and biosynthesis of fats and macro molecules (nucleic acid and proteins).[2] Reaction of energy rich compounds viz. ATP (Adenosine triple phosphate), NADP (Necotinamide Adenosine of hydroxide ion phosphate), ADP (Adenosine diphosphate), AMP (Adenosine monophosphate), FAD (Flavin Adenine nucleotide), NADH (added H), $FADH_2$ (Addition of H_2) are conducted by Phosphate. Phosphorus helps in acid –base balance and transfer of fatty acids.

Likewise, in plants also phosphorus is second important macronutrients after nitrogen in the list of 14 elements for plant growth.[3] Some of these essential elements get removed from the soil, plant and growing environments and some get chemically changed. These facts make plant deprived of essential elements hence, productivity is drastically reduced. These elements get transformed chemically under decomposition that emanates chain of problems of environment, food shortages, behaviour of the ecosystem and disruption of ecosystem services.

The phosphorus nutrition for animals and plants are researched upon and ever remain as important topic for scientific research. The nutrition of phosphorus is driven by plants from the soil. The sources of phosphorus have largely been the rock phosphate inorganic, which are supplemented to the soil. These plants as primary auto producers become first produce in the food chain and subsequent small plants and animals become the food chain and food web.

The phosphorus cycles in terrestrial and aquatic ecosystem are described by textbook.[4] Phosphate minerals are located in rocks and soils; phosphate exists in soluble and insoluble form. Terrestrial plants absorb inorganic phosphate salts from soil and convert these in to organic phosphates. Animals obtain the phosphate by eating the plants. Plants and animals after their death and decay return phosphates in to the soils, which are converted in to humus by the action of soil micro-organisms. Part of soluble phosphate move to the water bodies which are used by the phytoplankton that in turn get consumed by the *zooplankton* and animals. The dead organics again return to soluble phosphates.

The common forms of phosphorus in wastewater are orthophosphate (PO_4), polyphosphates (polymers of phosphoric acids) and organically bound phosphates. Conventional wastewater treatments remove about 20 to 40 % of influent phosphorus. In the United States of America effluent limit range from 0.1 mg/l to 2mg/l as P.

Aquatic productivity is limited by supply of raw materials and biological efficiency of converting them in to various life forms**;** basic form of life, algae and other green plants are called primary producers. Animals being unable to manufacture their own foods, obtain their energy and nutrients by eating the plants and smaller animals. Primary producers algae, primary consumers animals such as fly nymphs, copepods and water flees and several food chains connected form the food web**.** Prey species such as blue gills effectively hide from the predatory fish. Thus, total numbers of small fishes in the waste water having profuse growths of algae, increase dramatically compared to large game species.[5] Birds are the secondary consumers as they feed on the insects and fish fingerlings.

The phosphorus has been subject of concern since long back

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with regard to food and nutrition for plants and animals. In the recent years phosphorus has been used for various other purposes such as phosphorescent dye[6] and additive in many bright colours making sources. Thus, availability of refined phosphorus is becoming important element for lucrative enterprises developments. Therefore, search of refined phosphorus becomes equally important. In the scientific endeavours many proactive efforts are resorted to augment supply of the scarce materials. For example, one very important effort has been on the water harvesting (in long past and researched by many researchers) and biological water harvesting.[7] Biological nitrogen fixation and phosphorus solubilisation by study[8] is also similar attempt by using soil bacteria. Biological fixation of nitrogen by leguminous crop based bacteria is widely known and ongoing practice. In the similar way the objective of the present study was to explore ways and means of fostering availability of phosphorus. In the phosphorus cycle part of phosphorus intake by animals get excreted and make small, but a sustainable resource. So far presence of phosphorus in waste waters had been known to cause ecological and environmental problems of pollution and eutrophication in the water resources. The research effort devoted in this study was aimed at developing way to remove the phosphorus being added by the way of bird droppings to eliminate the water pollution problem due to aquatic bird dropping and make its other use to develop lucrative applications.

Guano is the name given for this bird dropping, which is rich source of phosphate fertiliser. Some efforts to artificially generate the bird droppings by erecting raft in the coastal areas also reported by Horobin.[1] The aquatic birds which derive their foods from fish are known to produce phosphorus in droppings. However, no efforts have been made to catch the Guano. This study aimed at harnessing the collection and exploring multiple use of the phosphorus from the bird droppings.

The manuscript presented here contains materials and method with regard to substantiation of phosphorus content in bird droppings vis a vis materials from other sources, description of setups for biological harvesting covering entire domain where birds sit for prey and for their night stay. The setups sufficiently facilitate long time sitting of birds, except time spent on travelling by flying. The result comprises substantiation of potential of availability of phosphorus, followed by the prospects of research result under various sub heads. The discussion and SWOT analyses of the research are also presented followed by the conclusion and need for further research. Thus, study covers in detail the novel research on status and development of important element viz biological phosphorus.

Materials and methods

Acquisition of data for substantiation of Phosphorus potential in bird dropping vis a vis other sources

The exhaustive literature survey revealed that Gustafson[3] presented valuable data on sources and content of macro plant nutrient viz nitrogen, phosphorus and potassium. In this study the data reported by Gustafson[3] on the compounds where phosphorus is available were selected for supporting and substantiating the facts. Thus, use of such published data in no way is forfeiting the publisher's copy right. Instead, it is an extension of well known and popular data for innovative application that results in added advantage in saving of research time and escape limitations imposed by paucity of budget.

The setups for biological phosphorus harvesting

The setups for biological harvesting of phosphorus were developed to extract the phosphorus from various sites as it naturally occurs.

The bird droppings contain N,P,K Details of setup for night sitting of birds sitting on banks, floating raft in wide stretch water bodies and collection setup for birds sitting on projecting boulders are available in another study.[9] The setup for collection of bird droppings from the night sitting comprises spreading of litter or polyethylene sheet which can be replaced at some interval. The shore side raft includes wooden or plastic made. Likewise, the floating raft is anchored in mid stream or at any desirable distance from the shore. The cover in the boulder zone comprises stretchable rubber cap that can be replaced. This cover is provided with collection bottle. Thus, setups described in the present and earlier study cover all aspects of collecting droppings except that occur during birds flying. Thus, the setup for biological harvesting is simple, can withstand aberrant weather condition and facilitate easy collection of sticky biological phosphorus.

In view of the waxy nature of the phosphorus the width of stand for sitting should be in 5-8 cm and below this the dropping catching tray should be located. The surface of the catching tray should be fitted with a thin glass sheet laid at slope to drain the liquid substance phosphorus. The sticky dropping can be scrapped from the glass surface by using wide knife. Thus, four types of collections setups become easy and organisable simple setups for biological harvesting of phosphorus from the droppings of birds feeding on the aquatic foods viz the fish fingerlings. These setups can be made from ordinary wooden planks or fabricated in plastic mouldings and painted in the colour matching to the surrounding and ground. The setups can be nailed down for stability.

Results

The results of the study under different heads are presented in the following.

Substantiation of the phosphorus potential sources

Table 1 contains list of different sources of phosphorus and corresponding content. The animal ammoniates are renewable source which is aimed at harnessing the biological phosphorus. The results are viewed from various aspects.

Selected data from Gustafson, 1939/2010 to support the hypothesis of potential of phosphorus resources. Request was been put up to the Publishing Company Agrobios, Chopasani Road Jodhpur, India. For grant of permission for use of data, by citing the source, for entirely a different scientific purpose.

Potential sources: Phosphorus is available in the maximum percentage in the animal ammoniate in the bone meals. The guano viz dropping of aquatic fed birds is the maximum renewable resource of the phosphorus (Table 1). The content in the fish and other bird viz poultry and sheep manures are of lower than that in guano. Vegetative plant ammoniates contain low magnitudes of phosphorus which offers low potential for extraction and commercialisation. Many manufactured fertilisers contain high percentage of P but are difficult to get and costly.

Magnification of the phosphorus content: The fish (acid) contain phosphorus 3-6 percent and tankaged (with fresh water) 4-8 percent. Thus, tankaged fish brought more (2.2 to 3.3 times) magnification over the fish in acid water. This implies that fish reared in the ponds and rivers will permit better harvest of phosphate than from the sea fish fed birds. Thus, there is some indication that artificial fish ponds reared fish fingerlings when fed to the birds of aquatic ecosystem dependent or alike species will produce better harvest of phosphorus than the sea fish fingerlings eating birds.

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Table 1 Nitrogen and phosphorus containing compounds*

S. No	Compounds	Phosphoric acid content, percent
Animal ammoniates		
1	Bone Meal Raw	20-25
2	Bone Meal Steamed	25-30
3	Fish (Acid)	3-6
4	Fish Tankage	4-8
5	Guano*	10
6	Meat Meal	1-5
7	Milogranite	1-5
7	Poultry Manure (Dried)	0.65
8	Sheep Manure	0.86
9	Tankage	3-13
Vegetable ammoniates		
10	Castor meal	1-1.5
11	Cocoa shell	1.0
12	Cotton seed	2-3
13	Linseed meal	1.5
Inorganic and manufactured ammonites		
14	Ammophos (1)	48
15	Ammophos (2)	20
16	Ammoniated superphosphate	16
17	Leunaphos	20
18	leunasalpeter	20

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The dropping of the birds feeding substantially on the fingerlings contain phosphorus 10 percent (Table 1). The P content of guano is almost 15 times more stronger than that in the poultry bird dropping, which is known the best sources of biologically available P. The guano the substance in this study will be a very strong source of P. Further, the phosphorus is useable for other industrial applications in very small quantity in the order of one tenth of nanometre. Therefore, inspite of production of small quantity guano derives significant high value for commercialisation.

The quality characters: The phosphorus is available in fixed and soluble form. The biologically produced P from the guano will be soluble phosphorus (organic phosphate); therefore, it will be of superior to inorganic phosphate in quality.

Phosphorus harvesting setups

The novel setup described in the study is simple, organisable and largely inexpensive for biological harvesting of phosphorus. The setup facilitates collection of new and better alternative of phosphorus viz biological phosphorus as novel resource that has multiple utility.

The birds sit on the tall trees along the banks for their night stay. Their dropping will be coming throughout the night and get collected in the litter spread to receive it. If the ground is smooth, a thin layer of litter such as wheat straw, grass and paddy straw chaffs or saw dust will be suitable. These materials after collection can be used as soil amendments in the fields. Use of poultry manure and sheep manure are well known and in practice and guano litter material is similar with respect to handling.

Quantity and Quality of droppings harvestable from different collection sites and potential uses

All harvestable guanos have similar strength of magnification. The guano from night sitting collected from litters, being larger in volume should be used for supplementation of phosphorus for crops. The guano collected from the aquatic banks or right from the inside of river, being pure should be processed for preparation of phosphorescent dye for various purposes.

Processing of harvested phosphorus

The admixture of bird dropping and water when brought to the laboratory will be processed by chemistry expert. The produce needs expert chemical analysis and product development.

Prospecting of research results

The harvested phosphorus becomes an important source of organic phosphorus. Its multiple uses are presented in the following sub heads.

Implications of results

Bird droppings (already known and existing as guano,[1,3] contain high amount of phosphorus. The bird droppings are also known to cause water pollution by enhancing P and N contents leading to eutrophication a cause of damage to water bodies' existence and worsening of water quality. Thus, research and development under the present study brings two directional solutions ie removal of the pollutant and making multiple industrial alternative uses. In order to supplement large demands to come up, the present study opens avenue for artificial production of phosphorus along the existing and created inland fisheries, ponds and lakes with fresh water.

The birds collectively sit and wait for long hours in search of their feed of small fish on the bank of rivers and on the boulders existing in the river bed having elevation more than the flow depths. The phosphorus is one of the major nutrients for the plants. The profuse growth of water hyacinth absorbs oxygen present in the water that leads to fish kill and deterioration in the water quality. This phosphorus can be extracted by harvesting as dealt with in the present study can

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be further manoeuvred by the incorporation of functions of sulphur cycle[10-13] to enhance productivity of crops. Therefore, whatever quantity of phosphorus that gets mixed up in the long stretch of rivers and brings bad effect to the quality of water can be manoeuvred to eliminate the bad effect on one hand and produce useful good effects on the enhancement of productivity of nitrogen and water, on the other.

The collection of the bird droppings along strategic points (where birds cluster along the bank) can be done by erecting bird sitting stands/ rafts. The stands should be equipped with collecting tray channel as an when it is dropped or when the accumulated droppings get washed during rains and gets collected in a jerry can attached to it. Further, in the river reaches of boulder zones, birds sit on boulder extruding above water surface and keep waiting for the fish for their feed. The protruding stones on which birds sit can be covered with a plastic cap with bottom edge formed as channel and having provision of a collection bottle. The droppings get washed down and collected in the bottle which can be replaced after some rain events. This cap and collection bottles can be again changed at intervals. Thus, the rare natural resource which produces undesirable effects to the water resources will be harnessed to bring to beneficial uses by biological harvesting of phosphorus.

The phosphorus in addition to being an essential major nutrient for the plant growth is useable in many other applications such as tracer dye and as phosphorescent organic materials. The quantity of the phosphorus needed for other than plant nutrient is very small (at levels of tens of nanograms /per litre (~1 in 1011). Hence requirement of guano is very small amount of solution for injection in the hydrometric practice of measuring river/stream discharge as direct method.[14] The organic phosphorous will be new source for soap manufacture, colour dye and paints in building materials and eradication of ultraviolet light from fluorescent tubes and mercury vapour lamps etc. The use of phosphorescent dye is well known in their commercial uses. Idea of exploration of natural phosphorescent dye source did not emerge earlier, perhaps because there was no easy way to collect these droppings. Now the ways and means are made known by the present study which opens a frontier to harness the bird dropping from aquatic ecosystems for beneficial uses. The use of the phosphorus from the bird droppings needs some research efforts with regard to refinement to eliminate the N content present in it.

Feasibility and scope for harnessing

It is possible to harvest phosphorus in guano from birds feeding on the fish fingerlings. The magnification of P by the birds is almost 15 fold higher than the content in the other birds viz poultry. Thus, there is good scope for harvesting biological phosphate from the bird droppings in the aquatic ecosystems of sea, rivers and lakes. There is also indication that guano collection farms can be organised to produce quality biological phosphorus, which can be chemically refined of nitrogen and used in fluorescent appliances such as tubes and bulbs for illumination and paints as well as soap manufacturing. Thus, a new source of phosphorus will be possible by the harvesting of the biological phosphorus.

Extension of the research for collection of another nutrition ie Iodine (I)

Iodine is produced from the cod lever oils produced from the fish. The magnification may also be existing in the bird droppings as in case of the biological phosphorus. Thus, the iodine deficiency can be removed in large population and disease of the goitre controlled to larger extent. This indication and speculation needs to be experimentally explored.

Non dispensable use of water resources in pond, lakes, rivers and ocean, a way to interlink people, environment and water bodies

The fish reproduction and dependence of aquatic birds has been all time known function in the aquatic ecosystems. Likewise bird droppings have been occurring and causing water pollution. Harnessing of P from the bird dropping adds a new avenue to link ecosystem and people in the non dispensable water use. Water is already becoming scarce commodity and the biological harvesting makes indispensable use of water. It opens scope for development of phosphorus harvesting along the existing or created ventures of fisheries. Thus, it creates a strong link between aquatic ecosystem, environment and people. Vast ocean stretches (Ocean two third and terrestrial one third approximately) offer unlimited scope for phosphorus harvesting. Contribution of ocean in absorption of carbon dioxides has been well recognised. This research enables make ocean resource to produce biological phosphorus and bring new global business and improvement in the quality of living.

Multiple uses of biologically harvested Phosphorus

The composition of Phosphorus in different types of substances is available in Gustafson.[3] The phosphorescence properties and areas of its uses are also available in Horobin.[6]

Results of the present research will be applicable for various purposes (Table 2). The ecosystem service based application, pollution elimination at sources, wastewater treatment domain increase ecosystem services. The other uses are known, but its extensive use had been limited by availability and the cost of product. Application of biological harvesting of phosphorus will produce material at lower cost by way of increasing availability than that exists when it is scarce. This situation will promote use of the biological phosphorus, thereby conserve resources and make indispensable use of water and enhancement of resources use efficiency.

Discussion

Use of well known popular data and substantiation of fact becomes scientifically acceptable research. The study demonstrates utility and application, and promotion of very important subject of food and nutrition, ecology and environment and enhancement of resources uses in the global perspective, as was done by this author for subject of nitrogen N.[9]

The study created new and better alternative sources for harvesting and production of biological phosphorus, that had not existed in the known phosphorus cycle. Thus, by using already known and widely accepted data for more than seven decades, Gustafson,[3] a new dimension on availability and production of phosphorus could be devised. This study sensitises world scientific community to harness the vast resources from the ocean.

This research opened new frontier of making non dispensable water use, be it fresh water, waste water or salty and brackish water in ocean and sea. The extraction of phosphorus pollutant enables attempting reduction of eutrophication and pollution.[10,15] Thus, there are multiple benefits. The study has enabled emergence of new perception that ocean can be regarded as a planet for deriving resources for human welfare.

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Table 2 Extension of multiple uses of biologically harvested phosphorus

Areas of application	Existing known Action	Example of Application	Supporting References
Enhancement in the Aquatic Ecosystem Services			
Reduction of water pollution at source	Not recognised as serious problem	Reduction of eutrophication in whatever volume it may exist	[5]
Wastewater management and utilisation	Recognised but low reliance is observed	Birds will extract the growing fish fingerlings sprawling in the eutrophicated water bodies	[5]
Non-Dispensable Water Use for Bonus Producing Enterprises			
Utilisation of inland pond, lakes and rivers fisheries	New secondary food consumer birds can be reared	New farm on the line of poultry and duckery farms can be opened for biological phosphorus harvesting	This research
Linking of people, environment and ocean	Coastal areas erected raft and dispensed food to invite birds	Collection from costal	[1]
Linking of vast ocean aquatic ecosystem, people and bird kingdom	Entire domain of bird dropping collection covered	Litter collection, raft collection, boat collection and cap collection	This research
Extension of Multiple Uses			
Agriculture	Not specific	Biological phosphorus will be in high demand for organic agriculture	[11-13]
Phosphorescent dye	Phosphorus dye find place for textile bright washing	Basis for use explained	Becoming accepted by the textile manufacture company.
Building materials	Trace additive for bright colour getup	It will find uses in the paints and polishing material	[6] and this study.
Textile colouring	Fast colour printing	The phosphorescent dye additive will increase the brightness of colours	[6] and this study.
Cloths and clothings maintenance, soap and detergent	It removes yellow tint and produces white tint	Some soap of bands used.	[6]
Instrumentation	Used as phosphorescent chemical dye	Used in instrumental panel and dash boards	[6]
Scientific research studies	Used as tracer dye in scientific research on velocity measurements	Used in chemical method o direct measurement of river discharge	[14]

The setup is simple, business generating, resource for food, nutrition and medicines, industrial uses for creating enterprises etc. It creates new resource from terrestrial and aquatic ecosystems and enhancement of ecosystem services. Thus, this research enables linking of people, birds, ocean and environment by a simple and organisable linkage.[9]

The prospecting content of the study inspires worldwide researchers of biology, fishery, avian and ocean scientists to collect biological phosphorus harvesting of phosphorus and create better world by use of bio phosphorus for human, animals and plant.

This research is a breakthrough in exploration of non-dispensable use of all qualities of water, which is getting scarce year after year, protection of water bodies from eutrophication and enhancing use efficiency of the resources. The environmental disaster of nitrogen[9] phosphorus can be attempted with new approach. These aspects become new vision for attempting solution to problems developing from ocean and environment.

SWOT analyses

Strength, opportunity, weakness and threat associated with any new development should also be seen for this study as well. These aspects have been applied for these studies in the following.

Strength

This study substantiated with data selected from well known and widely distributed reference viz Guftafson,[3] has acquired scientific merit and academic strength, and remains flawless and comprehensible by scientific community. The setup for collection of bird dropping, protection of water bodies from phosphorus pollution can be fostered. These facts provide strength to the study of biological phosphorus harvesting.

Weakness

In this study there was lack of data generated at field scale by the researcher and this shortfall is overshadowed by the novelty of the presented perception and concept of the present study and utility of biological phosphorus.

Opportunity

The phosphorus is well accepted element for food and nutrition for human, animal and plants, and remains in high rising demand. The fact that biological phosphorus harvesting makes such rare and unknown activity provides very good opportunity for creating new and alternative resource. The biological phosphorus becomes ideal source for organic farming, production of iodine, to be used in industrial applications such as paints and textile colouring. Thus, the present study has created tremendous opportunity. It enables create business, particularly indispensible use of water, which had not been achieved earlier. Thus, this novel study created global activity of linking ocean (occupying two third part of the earth surface), which can be regarded as vast natural resources. It enables linking of people, environment and ocean for creating new business. This study also promotes utility of rearing of birds in aquatic and terrestrial ecosystems.

Threat

There is no threat or any scientific flaw, adverse side effect of application of this research for development.

Conclusion and research needs

The aquatic ecosystem, dependence of birds on fish fingerlings has existed for all times and same was the situation about the bird droppings. This study, while substantiated the potential of phosphorus harvesting by using long time existing and known, academically accepted data, has brought in a new approach to biologically harvest this bird dropping i.e. guano, rich source of phosphorus. Thus, this study enables method for enhancement of ecosystem services and extension of its uses for development of new enterprises on the inland fisheries and enabling strong linkage between people, birds, ocean and environment. Non dispensable use of water resources suggested in the present study leads to conservation and efficient utilization of primary and secondary natural resources of global as well as local domain.

Further researches are needed to extend study to determine the magnification of iodine (another important nutritional product derived from ocean) content in the guano, simple and effective method of refinements of individual contents of guano as well as development of products of industrial application.

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None.

Conflicts of interest

None.

References

1. Melloul A, Collin M. Key natural and anthropogenic parameters enhancing the effect of sea level rise: The case of Israel's Mediterranean coast. Ocean & Coastal Management. 2009;52(1):39–46.
2. Field CB, Mortsch LD, Brklacich M, et al. North America. In: Parry ML, et al. (Eds), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. 2007;pp.617–652.
3. CCSP. Coastal Sensitivity to Sea–Level Rise: A Focus on the Mid–Atlantic Region A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. US Environmental Protection Agency, Washington, DC, USA. 2009.
4. Karl TR, Melillo JM, Peterson TC. Global climate change impacts in the United States. Cambridge: Cambridge University Press. 2009.
5. IPCC. Climate Change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. *Cambridge University Press*, Cambridge, UK, pp. 976. 2007.
6. Church JA, White NJ. A 20th century acceleration in global sea level rise. Geophysical Research Letters. 2006;33(1):1–4.
7. Lambeck K, Anzidei M, Antonioli F, et al. Sea level in Roman time in the Central Mediterranean and implications for recent change. *Earth and Planetary Science Letters*. 2004;224:563–575.
8. Nicholls RJ Small C. Improved estimates of coastal population exposure to hazards released. *EOS Transactions*. 2002;83(28):303–305.
9. IOC/UNESCO, IMO, FAO, UNDP. A Blueprint for Ocean and Coastal Sustainability. IOC/UNESCO, Paris. 2011.
10. Nicholls RJ, Tol RSJ. Impacts and responses to sea–level rise: A global analysis of the SRES scenarios over the twenty–first century, Philosophical Transactions of the Royal Society A. 2006;364:1073.
11. Marbaix P, Nicholls RJ. Accurately determining the risks of rising sea level, EOS Transactions. 2007;88(43):441–442.
12. Travers A, Elrick C, Kay R. Background Paper: Climate Change in Coastal Zones of the Mediterranean. Priority Actions Programme, Mediterranean Regional Activity Centre, Coastal Zone Management Pty Ltd, Claremont, Australia. 2010.
13. European Commission. Sustainability Report. Luxemburg: Office for Official Publications of the European Communities. 2009;pp.160.
14. Carillo A, Sannino G, Artale V, et al. Steric sea level rise over the Mediterranean Sea: present climate and scenario simulations. Climate Dynamics. 2012;39(9/10):2167–2184.
15. Tsimplis MN, Marcos M, Colin J, et al. Sea level variability in the Mediterranean Sea during the 1990s on the basis of two 2D and one 3d model. *Journal of Marine Systems*. 2009;78(1):109–123.
16. Tsimplis MN, Baker TF. Sea level drop in the Mediterranean Sea: An indicator of deepwater salinity and temperature changes? *Geophysical Research Letters*. 2000;27(12):1731–1734.
17. Paulopoulos K, Chalkias C, Karimbalis E. Potential impact of sea level rise on Mykonos, Delos, Rinia islands, In: 6th Pan–Hellenic Geographical Conference, *Thessaloniki*. 2002;pp.3:469–476.
18. EUROSTAT. Coastal regions. In: Asa Onnerfors (Ed.), Eurostat regional yearbook 2011. Luxembourg: Publications Office of the European Union, Belgium. 2011.
19. Coudert E, Larid M. IMAGINE: un ensemble de méthodes et d'outils pour contribuer à la gestion intégrée des zones côtières en Méditerranée, Vertigo–la revue électronique en sciences de l'environnement, Dossier : Les littoraux et la gestion intégrée des zones côtières. 2006;7(3).
20. Devoy RJN. Coastal Vulnerability and the Implications of Sea–Level Rise for Ireland. *Journal of Coastal Research*. 2008;24(2):325–341.
21. Barth MC, Titus JG. Greenhouse effect and sea level rise: A challenge for this generation, Van Nostrand Reinhold, New York, USA. 1984;pp.324.
22. Milliman JD, Broadus JM, Gable F. Environmental and economic implications of rising sea level and subsiding deltas: The Nile and Bengal examples. Ambio. 1989;18(6):340–345.
23. Warrick RA, Barrow EM, Wigley TML Climate and sea level change: Observations, projections, implications. Cambridge University Press, Cambridge. 1993.
24. IPCC. Climate change 2001: impacts, adaptation and vulnerability. Contribution of the working group to the 3rd assessment report of the intergovernmental Panel on Climate Change. World Meteorological Organization, Geneva. 2001;pp.124.
25. IPCC. Climate change 2001: impacts, adaptations and vulnerability. In: McCarthy JJ, et al. (Eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge. 2001;p.75.
26. National statistical Survey of Greece. Population, housing and buildings Census 2001. 2003;p.18
27. Dubois RN. How does a barrier shoreface respond to a sea–level rise? Journal of Coastal Research. 2002;18:2.
28. Bruun P. Sea–level rise as a cause of shore erosion. Journal of Waterways and Harbors Division. 1962:117–130.
29. Rahmstorf S, Foster G, Cazenave A. Comparing climate projections to observations up to 2011. Environmental Research Letters. 2012;7:4.
30. Al–Buloshi A, Al–Hatrushi S, Charabi Y. GIS–based Framework for the Simulation of the Impacts of Sea Level Rise and Coastal Flooding on Oman. Journal of Earth Science & Climatic Change. 2014;5(10):1–6.

31. Neumann JE, Hudgens DE, Herter J, et al. Assessing Sea–Level Rise Impacts: A GIS–Based Framework and Application to Coastal New Jersey. Coastal Management. 2010;38(4):433–455.

32. Nicholls RJ, Tol RSJ, Vafeidis AT. Global estimates of the impact of a collapse of the West Antarctic ice sheet: an application of *FUND*. Climatic Changes. 2008;91(1–2):171–191.

33. Valiela I. Global coastal change. Wiley–Blackwell, London. 2006;pp.376.

34. Dasgupta S, Laplante B, Meisner C, et al. The impact of sea level rise on developing countries: a comparative analysis. Climatic Change. 2009;93(3–4):379–388.

35. Nicholls RJ. Coastal flooding and wetland loss in the 21st century: changes under the SRES climate and socio–economic scenarios. *Global Environmental Changes.* 2004;14(1):69–86.

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