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APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) TO ASSESS THE ROLE OF COVID-19 LOCKDOWN IN THE DOMAIN OF ESTUARINE ACIDIFICATION

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Abstract

The branch of computer science that deals with the simulation of variables with the help of a computer are termed Artificial Intelligence (AI). Here we attempt to predict the pace of acidification on the Digha coast of the Bay of Bengal based on available datasets of more than three decades. The ground zero observation on the data set reveals a decreasing trend of pH since 1984 with a sudden hike in premonsoon 2020, the period coinciding with the COVID 19 lockdown phase in the Indian sub-continent.

Keywords: Artificial Intelligence (AI), Digha coast, aquatic pH, COVID 19 lockdown phase

I. Introduction

The inter-relationship between human societies and nature and human civilization is a bit complex. Nature provides ecosystem services of varied categories

to sustain human civilization [VI], [X], but exploitation of natural resources by human beings alters the ecosystem to a great extent [XII], [VII]. The emission of carbon dioxide at an exponential rate in the history of the past 66 million years is an example of the massive use of fossil fuels by human beings [XXV]. About 26% of the released carbon dioxide after getting dissolved in the aquatic phase of oceans, seas, bays, and estuaries during the period between 2005 and 2014 altered the chemistry of the seawater and resulted in the lowering of pH, a phenomenon is commonly known as acidification [IV], [IX], [XI]. The footprint of acidification is also witnessed in several Indian estuaries [I], [VIII] [XXI], [XXII] which is keenly related to a high degree of anthropogenic activities like the discharge of sewage and industrial wastes without treatment in the nearby estuarine water, discharge of wastewater from shrimp farms, untreated or partially treated sewage/wastewater from tourism units, etc.

II. Materials and Methods

More than three decades of data (1984-2020) were compiled from the archives of the Department of Marine Science, University of Calcutta, and Department of Oceanography, Techno India University, West Bengal for this study. Several kinds of literature on different aspects of coastal West Bengal have been published since the last three decades [II], [III], [V], [XIII-XVIII], [XIX], [XX], [XXIII], which have been used as the benchmark of the present study.

For the observational station, Digha at least five samples were collected from the surface during high tide conditions within 500 meters of each other.
The pH was obtained *via* a portable pH meter (Hanna, USA), which has an accuracy of ± 0.02. The collection method did not change since 1984.

Artificial Intelligence was finally applied to forecast the fluctuation of aquatic pH that is detrimental to marine and estuarine biodiversity. With this surface water pH data of 37 years on the Digha coast, we carried out a time series modeling to visualize the trend of the variable using a nonlinear autoregressive model (NAR) treating seasonal pH values as inputs (Fig 1).

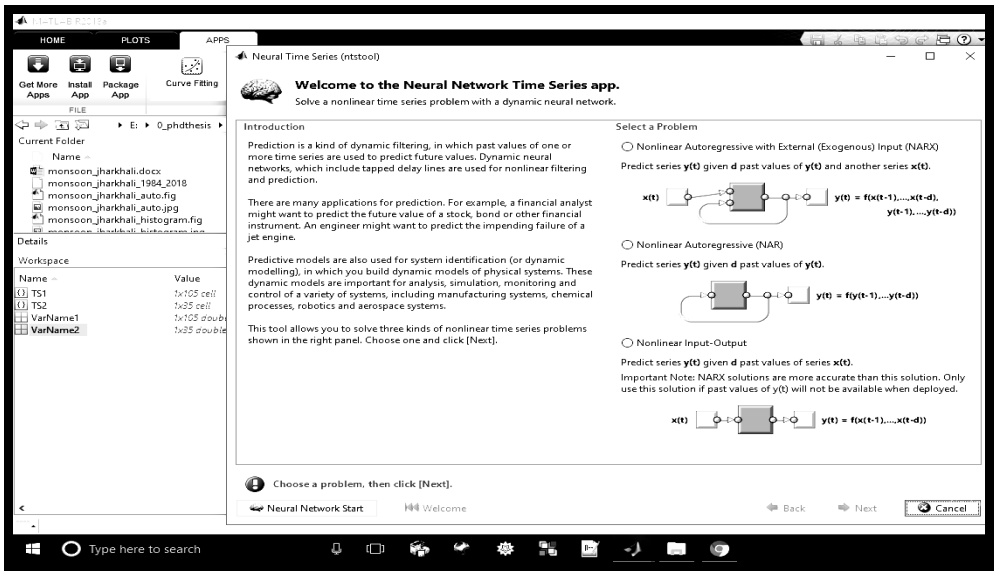

Fig 1. Non-linear Auto-Regressive (NAR) model for evaluating the trend of surface water pH in the coastal water of Digha

III. Results and Discussions

AI can predict futuristic behaviour (say over after 50 years or 100 years) based on real-time available datasets. AI can be applied based on certain principles like:

1. Reasoning, knowledge, planning, communication, and learning.
2. Perception and the ability to draw certain conclusions from the present database.

In recent times AI has a diverse field of applications, *e.g*. image-guided surgery and image analysis and enhancement. It has also its application in the fields of cardiology (CRG), neurology (MRI), embryology (sonography), complex operations of internal organs, etc. In scientific research fields related to environmental science, this technology is used to predict different variables from huge input data.

In the maritime state of West Bengal preferably in the Digha coast, the pH value is showing a decreasing trend in all three seasons (premonsoon, monsoon, and postmonsoon), which might be due to several adverse anthropogenic activities like the discharge of untreated sewage from the coastal tourism units and fish landing stations, industrial discharge, wastes generated from the shrimp farms, etc. (Fig 2, 3, and 4).

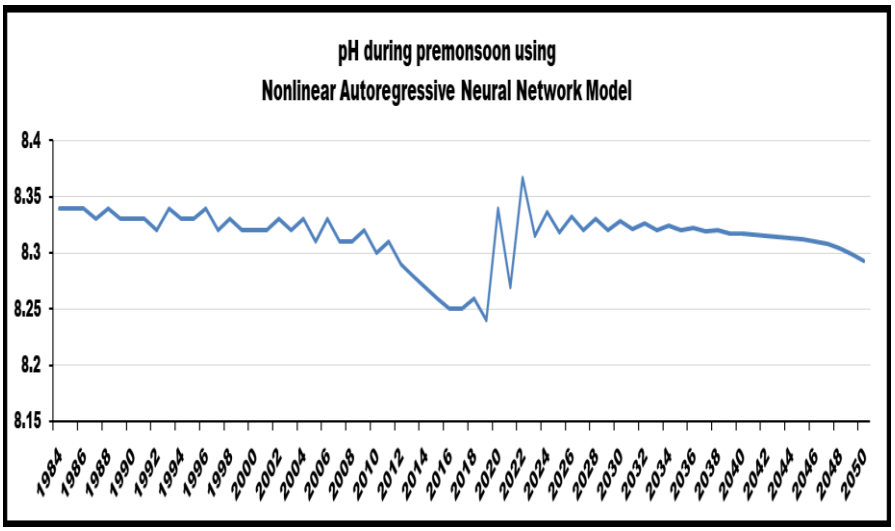

Fig 2. Predicted aquatic pH for Digha coastal water during premonsoon using Nonlinear Autoregressive Neural Network Model; real-time data from 1984 – 2020 has been used to train the model

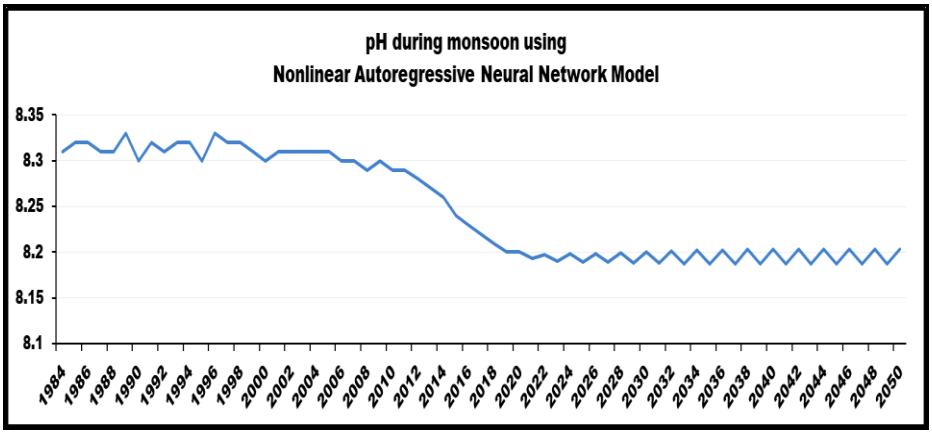

Fig 3. Predicted aquatic pH for Digha coastal water during monsoon using Nonlinear Autoregressive Neural Network Model; real-time data from 1984 – 2020 has been used to train the model

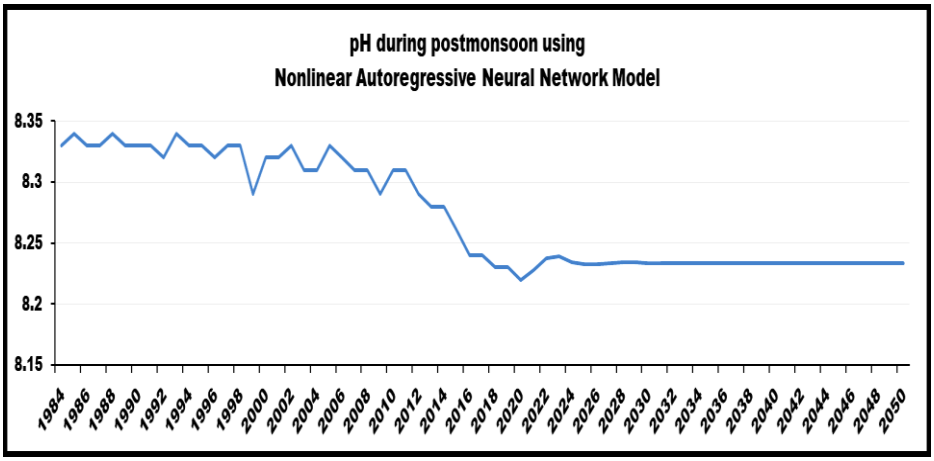

Fig 4. Predicted aquatic pH for Digha coastal water during postmonsoon using nonlinear Autoregressive Neural Network Model; real-time data from 1984 – 2020 has been used to train the model

It is interesting to note that the decreasing trend of the surface water pH is observed in both monsoon and postmonsoon seasons almost uniformly and the predicted aquatic pH values for these two seasons during 2050 are 8.20 and 8.23 respectively. However**,** the predicted value for the pre-monsoon season is 8.30 which is much higher compared to monsoon and post-monsoon and corresponds with the normal pH value of the inshore region of the Bay of Bengal [XVI]. This may be attributed to complete lockdown due to COVID - 19 in pre-monsoon (March – June 2020) due to which all industrial activities and other anthropogenic sources of pollution (like plying of vessels and trawlers, recreational tourism, shrimp culture, fish landing, etc.) were forcefully ceased to contain the spreading of the disease. Under such circumstances, there is a high probability of restoring the situation to its normal state as seen in premonsoon pH data during 2020. This peak has posed a check in the decreasing trend of aquatic pH and subsequently estuarine acidification during premonsoon. To sum up it can be advocated that the pace of acidification can be retarded if occasional lockdown is enforced in a certain period of the year to control the discharge of wastes in the estuaries.

IV. Conclusion

Acidification of estuarine and coastal waters poses a negative impact on the positive health of the ecosystem and biodiversity, particularly for shelled organisms. We predict using a nonlinear autoregressive model (NAR) treating seasonal pH values of the Digha coast as inputs (1984-2020) that monsoon and postmonsoon seasons in the future may face the vulnerability of

acidification in Digha coast of West Bengal, India. However, the lockdown phase implemented in the Indian sub-continent to stop the spread of Coronavirus during premonsoon acts as a game-changer to buffer the pace of acidification. Occasional closure of adverse anthropogenic activities may be considered at the policy level to restore the health of the ecosystem.

Conflict of Interest:

There was no relevant conflict of interest regarding this paper.

References

I. Agarwal S., Fazli P., Zaman S., Pramanick P. and Mitra A, "Seasonal variability of acidification in major estuaries of Indian Sundarbans", Global Journal of Engineering Science and Researches. vol. 6(4), pp: 493–498, 2019.

II. Banerjee K., Mitra A. and Bhattacharyya D. P., "Phytopigment level of the aquatic subsystem of Indian Sundarbans at the apex of Bay of Bengal", Sea Explorers. vol. 6, pp: 39–46, 2003.

III. Banerjee K., Mitra A., Bhattacharyya D. P. and Choudhury A., "Role of nutrients on phytoplankton diversity in the north–east coast of the Bay of Bengal", In Ecology and Ethology of Aquatic Biota (ed. Arvind Kumar), Daya Publishing House. pp: 102-109, 2002.

IV. Caldeira K. and M.E. Wickett, "Anthropogenic carbon and ocean pH." Nature. pp: 425: 365, 2003.

V. Chakraborty S. K. and Choudhury, A., "Distribution of fiddler crabs in Sundarbans mangrove estuarine complex, India", Proceedings of National Symposium on Biology, Utilization and Conservation of Mangroves. pp: 467–472, 1985.

VI. Costanza R., R. d'Arge, R. de Groot, S. Faber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, et al., "The value of the world's ecosystem services and natural capital", Nature. vol. 387, pp: 253–260, 1997.

VII. Costanza R., R. de Groot, P. Sutton, S. van der Ploeg, S.J. Anderson, I. Kubiszewski, S. Farber, and R.K. Turner, "Changes in the global value of ecosystem services", Global Environmental Change. vol. 26, pp: 152–158, 2014.

VIII. Dutta P., Pramanick P., Biswas P., Zaman S. and Mitra A, "Reversing the phenomenon of acidification in the River Ganges: A ground - zero observation" NUJS Journal of Regulatory Studies. pp: 89-92, 2020.

IX. Feely R.A., C.L. Sabine, K. Lee, W. Berelson, J. Kleypas, V.J. Fabry, and F.J. Millero, "Impact of anthropogenic CO_2 on the $CaCO_3$ system in the oceans", Science. vol. 305, pp: 362–366, 2004.

X. Heal G., "Valuing ecosystem services", Ecosystems. vol. 3, pp: 24–30, 2000.

XI. Le Que´re´, C. R. Moriarty, R.M. Andrew, J.G. Canadell, S. Sitch, J.I. Korsbakken, P. Friedlingstein, G.P. Peters, et al., "Global carbon budget 2015", Earth System Science Data. vol. 7, pp: 349–396, 2015.

XII. Liu J., T. Dietz, S.R. Carpenter, M. Alberti, C. Folke, E. Moran, A.N. Pell, P. Deadman, et al., "Complexity of coupled human and natural systems", Science. vol. 317, pp: 1513–1516, 2007.

XIII. Mitra A. and Choudhury A., "Dissolved trace metals in surface waters around Sagar Island, India", J. Ecobiol. vol. 6, pp: 135–139, 1994.

XIV. Mitra A. and Zaman S. In: "Basics of Marine and Estuarine Ecology". Springer. ISBN 978-81- 322-2705-2. 2016.

XV. Mitra A. In: "Ecosystem services of mangroves: An overview". Springer. ISBN 978-81-322- 2106-7, DOI: 10.1007/978-3-030-20595-9_1. 2020.

XVI. Mitra A. In: "Sensitivity of Mangrove ecosystem to changing Climate". Springer. DOI: 10.1007/978-; 81-322-1509-7. pp: 323, 2013.

XVII. Mitra A., Banerjee K., Sengupta K. and Gangopadhyay A., "Pulse of climate change in Indian Sundarbans: a myth or reality", Natl. Acad. Sci. Lett. vol. 32, pp: 1–7, 2009.

XVIII. Mitra A., Choudhury A. and Yusuf Ali Z., "Effects of heavy metals on benthic molluscan communities in Hooghly estuary", Proc. Zool. Soc. vol. 45, pp: 481–496, 1992.

XIX. Mitra A., Ghosh P. B. and Choudhury, A., "A marine bivalve *Crassostrea cucullata* can be used as an indicator species of marine pollution", Proceedings of National Seminar on Estuarine Management. pp: 177–180, 1987.

XX. Mukhopadhyay S. K., Biswas H., De T. K. and Jana, T. K., "Fluxes of nutrients from the tropical River Hooghly at the land– ocean boundary of Sundarbans, NE Coast of Bay of Bengal, India", J. Mar. Syst. vol. 62, pp: 9–21, 2006.

XXI. Ray Chaudhuri T., Fazli P., Zaman S., Pramanick P., Bose R. and Mitra A, "Impact of acidification on heavy metals in Hooghly Estuary", Journal of Harmonized Research in Applied Sciences. vol. 2(2), pp: 91-97, 2014.

XXII. Roy Chowdhury T., Vyas P., Zaman S., Roy A. and Abhijit A, "Surface water pH: A proxy to acidification of estuarine water of Indian Sundarbans", International Journal of Research and Analytical Reviews. vol. 6(1), pp: 1530-1535, 2019,

XXIII. Saha S. B., Mitra A., Bhattacharyya S. B. and Choudhury A., "Heavy metal pollution in Jagannath canal, an important tidal water body of the north Sundarbans aquatic ecosystem of West Bengal", Indian J. Environ. Protection. vol. 19, pp: 801–804, 1999.

XXIV. Swathi B., Shoban Babu S., Monelli Ayyavaraiah. : 'ARTIFICIAL INTELLIGENCE: CHARACTERISTICS, SUBFIELDS, TECHNIQUES AND FUTURE PREDICTIONS'. J. Mech. Cont.& Math. Sci., Vol.-14, No.-6, November-December (2019) pp 127-135. DOI : 10.26782/jmcms.2019.12.00010

XXV. Zeebe R.E., A. Ridgwell, and J.C. Zachos, "Anthropogenic carbon release rate unprecedented during the past 66 million years" Nature Geoscience. vol. 9, pp: 325–329, 2016.