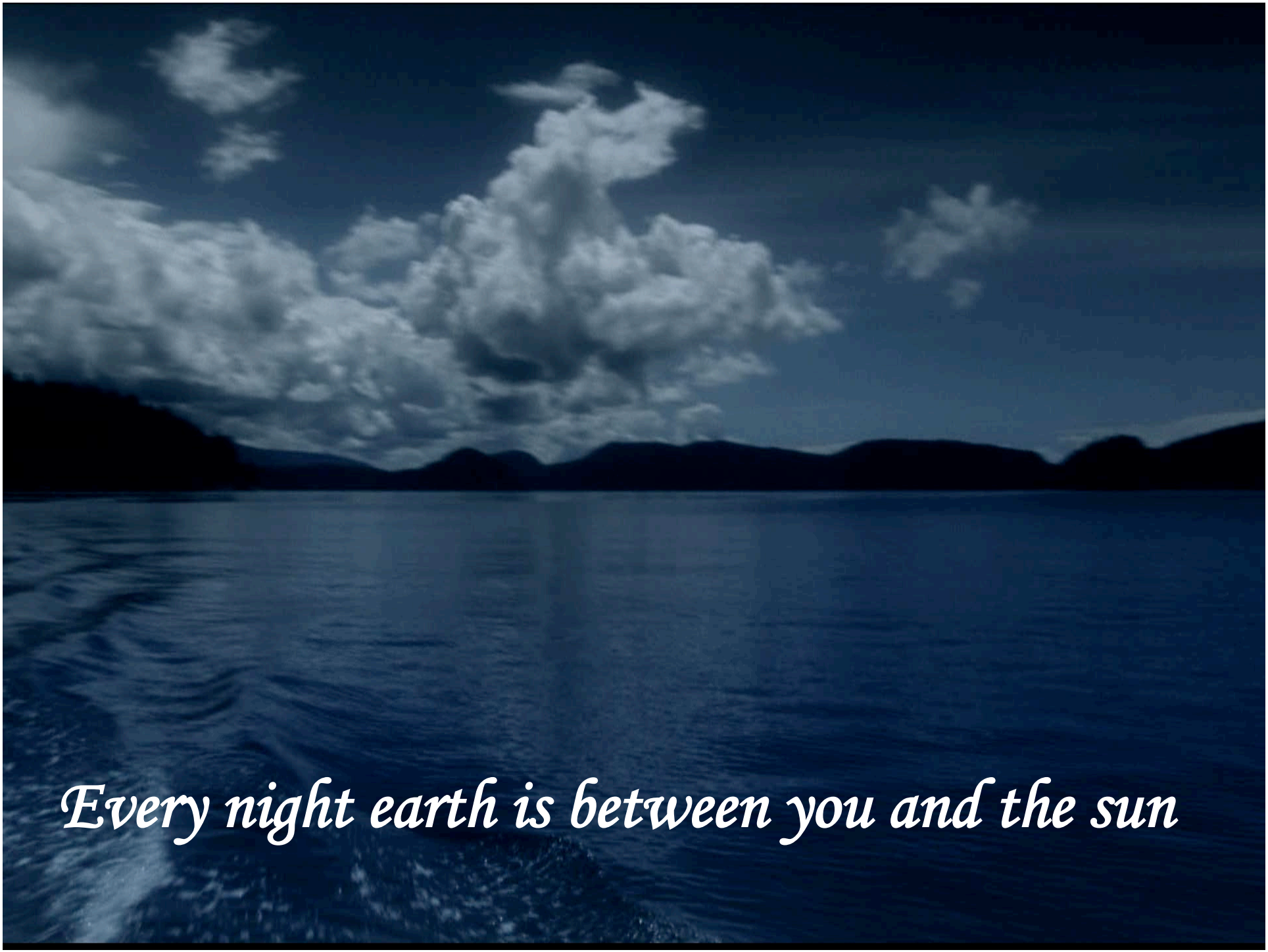
Eutrophication: Can nanophosphorous control this menace?

Deepika Bhalla, Siddhartha S. Mukhopadhyay [1]

Department of Soils, Punjab Agricultural University, Ludhiana – 141004, India
[[1] e-mail siddhartha_soil@yahoo.co.in]


Every night earth is between you and the sun


We are gifted with this……. Dream of a poet


But.....


Every morning view between
you and aquatic life in surface
water-bodies.....


is blocked by


blooms on SWB and


Eutrophication!


Eutrophication!

Eutrophication!

Eutrophication

A threat to quality of surface and ground water bodies (SWB) and to bio-diversity of the aquatic eco-system

It snaps dynamics of "human ↔ landscape ↔ aquatic" life support system

Why target P?

- Phosphorus has a very low solubility in soils,
- Range of P availability is $<10^{-8}$ M in some very poor tropical soils,
- In the order of 10^{-6} M in temperate soils,
- 10^{-5} M in many soils of moderate P status,
- And it can exceed 10^{-4} M in some well supplied soils.

- To maintain the desired level of P in soil solution; a key to productivity, excess amounts of P is added to soils, and the phenomenon continues for years.

- The annual surface runoffs is estimated between 0.01 and 3.00 kg P / ha and annual erosion of P-containing soil minerals is between 0.1 and 10 kg / ha (Brady and Weil, 2002).

- Thus phosphorous is leached with the surface run-offs and finally form sediments in the water bodies.

- As these sediments become anoxius, increments of transformation from solid to solution phase rises because of anaerobic conditions that facilitates reduction of Fe^{3+} and Mn^{4+} to Fe^{2+} and Mn^{2+} respectively.

Phosphorus turnover after 25 years of fertilizer experiment in a groundnut-wheat-sorghum cropping system at Junagarh (Gujarat).

Treatment	Initial P status	Nutrient addition	Nutrient removal	End of the experiment P status
	---------- kg ha^{-1} ----------			
F_1 Control	27.5	0	204	19.4
F_2 FYM	27.5	546	599	23.5
F_3 NP	27.5	1490	591	25.3
F_4 NPK	27.5	1566	778	25.7

Adapted with modification from Hadvani et al. (2006)

How can we increase productivity?

- It could be discerned from these experiments and also many other similar experiments conducted world over that small amounts of addition of phosphorus can remove excess P from soils provided solution P is maintained in such a manner that productivity is sustained.

Causes of P accumulation

- Excess application as a fertilizer
- Phosphorus buffering

- The phenomenon; phosphorus buffering is a major contributor to eutrophication and remains a major problem years after the release of P is brought under control.

- Critical levels in water that can trigger algae growth have been reported to be as little as 20 parts per billion (ppb)

Promises of nanotechnology

- Nanoscience and its applied sphere that is known as nanotechnology have potential to bring the next revolutionary breakthrough in agriculture-biased natural resource management.

- SEM, TEM, and AFM, and their attachments e.g., EDS are used for soil study.

- Electron waves in SEM and TEM and laser beam in AFM are used for coalescing micrographs.

- The advantages with EM are high resolution imaging, high magnification, and great depth of focus

Miracles of nano-P

- Addition of small amount of addition of P can remove excess P.
- Nano-P could possibly play a role in it
- P must be applied to soils in amount exact to the requirement of crop
- Nanoscience approach can deal with the twin contradictions – between low solubility and excess application

Miracles of nano-P

- Improve nutrient use efficiency
- Reduce P build ups in soils
- Reducing its load in SWB
- Checking contamination in drinking water
- Nano-technology has opened up new opportunities to improve nutrient use efficiency and minimize costs of environmental protection.

Nanoscience and nanotechnology have found applications for the production of food and protection of environmental quality by:

1. Improving efficiency of native and applied phosphorus in soils,
2. Regulation of essential and toxic elements, associated with phosphorous in pedosphere-hydrosphere continuum,
3. Ion transport in soil-plant system, especially in the rhizosphere,
4. Increased endeavor towards precision farming w.r.t. phosphorous.

What will nano materials do to the environment?

- Our expanding ability to synthesize nanoparticles for use in electronics, biomedical, ceramics, pharmaceutical, cosmetic, energy, environmental, catalytic, material etc. has alarmed concern for these particles role in environmental safety.

Year	Amount of Engineered material used
2004	2000 tons
2011-2020	58000 tons (expected)

Zeophonics

- System founded on the concept of interconnected nature of all life-forms and life-support-forms
- Relies on recycling and operation of system-components
- The system provides a framework where impetus and response are almost equal.

- This is the only means of survival in the extraterrestrial planets, space stations, and in the Antarctica

- To comprehend P dynamics, land and SWB system must be treated holistically, and sub-divided into components, each with realistic independent system-variables coupled with the processes, which tie these system variables.

- In nano-P ventures high resolution imaging not only provides evidence of the changes that occur in various phases, but also an indispensable tool to understand how dynamic systems operate.


Thank you