Yale 耶鲁大学-南京信息工程大学大气环境中心

Yale-NUIST Center on Atmospheric Environment

A discussion on the paper "Managing nitrogen for sustainable development".

Xin Zhang et al., 2015.

Reporter: Bian Hang

2016.3.25

Outline

- 1 Introduction
- 2 Theory
- 3 Results and Discussions
- 4 Conclusions

1 Introduction

- The lack of agricultural land N can lead to food safety, environmental degradation and climate change, and have a negative impact on crop yield and human health.
- Improve nitrogen-use efficiency (NUE) is increased crop yields decreased the most effective means of environmental degradation, and NUE was proposed for evaluating sustainable development goals, an indicator of progress.
- In research , social economy development and related N pollution, our analysis says many countries appear as a similar EKC curve, N pollution is increased before they are at the age of economic increase and decrease.
- Our analysis shows that global crop production needs NUE to improve from 0.4 to 0.7, so as to meet the food safety and environmental management of dual index of 2050.

2 Theory

2.1 Nitrogen budget database

$$N_{sur} = N_{fer} + N_{man} + N_{fix} + N_{dep} - N_{yield}$$

N_{fer} : fertilizer application

N_{man} : manure application

N_{fix} : biological fixation

N_{dep} : atmospheric deposition

N_{yield} :N in yield

N_{sur} : the inputs and the outputs is lost to the environment or remains in the soil

$$NUE = \frac{N_{yield}}{N_{fer} + N_{man} + N_{fix} + N_{dep}}$$

2.1 Nitrogen budget database

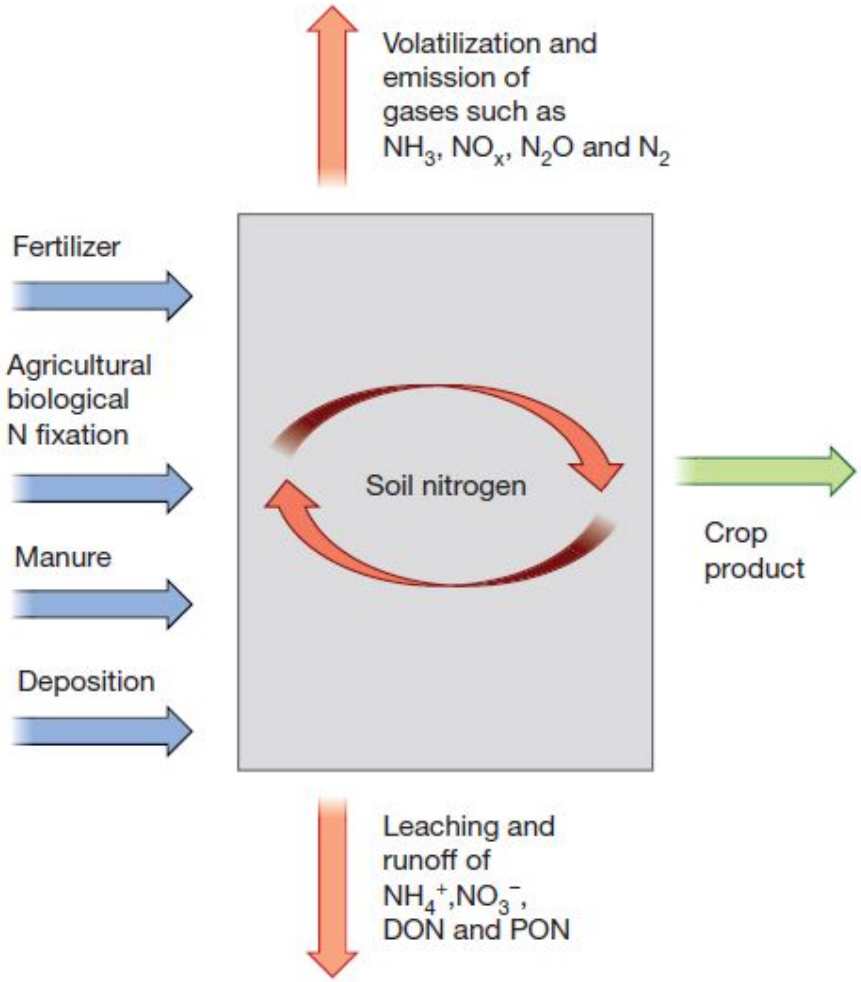

Figure 1 | An illustration of the N budget in crop production and resulting N species released to the environment.

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3 Results and Discussions

3.1 Patterns of nitrogen pollution

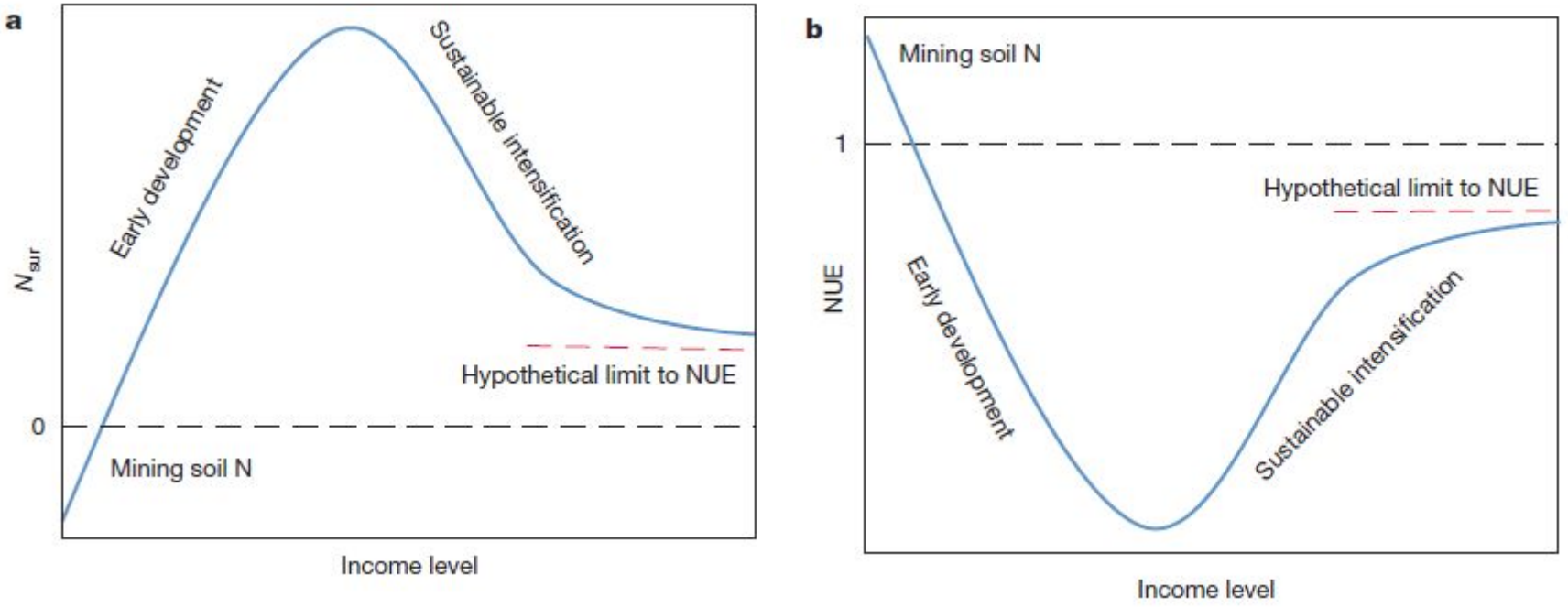

Figure 2 | An idealized EKC for Nsur and the related curve for NUE.

3 Results and Discussions

3.2 Variable turning points on the EKC

Table 1|The definition of five country groups based on regressions for each country. The analysis includes 113 countries.

ID	Definition of the Group ID	Relationship between GDP per capita and N surplus	Number of countries	Percentage of harvested area of 113 countries	Percentage of total N fertilizer consumption of 113 countries
1	p_c<0.05 & c<0	Bell-Shape (Figure 3a)	56	70%	87%
2	p_c<0.05 & c>0	U-Shape (Figure 3b)	16	13%	9%
3	p_b <0.05& p_c > 0.05 & b>0	Linearly increase (Figure 3b)	4	2%	2%
4	p_b >0.05& p_c > 0.05	Not significant (Figure 3b)	35	14%	2%
5	X (2007-2011)<0	Negative N surplus (Figure 3b)	2	1%	0%

Note: p_a, p_b, p_c are the significance level of the parameters a, b, c.

The model results are the outcome of the regression using the following model:
$Y = a + bX + cX^2$.

3 Results and Discussions

ID	Relationship	Number of countries §
1 a	Bell-Shape (after peak)	USA, Indonesia, Mexico, France, Philippines, Viet Nam, Spain, Germany, Romania, Italy, Nepal, United Kingdom, Hungary, Japan, Greece, Denmark, Republic of Korea, Cuba, Uruguay, Finland, Sweden, Austria, Netherlands, Costa Rica, Mauritania, Albania, Swaziland, Fiji
1 b	Bell-Shape (before peak)	India, China, Canada, Australia, Turkey, Bangladesh, Iran, Uganda, Morocco, Mozambique, Democratic Republic of the Congo, Egypt, Syria, Tunisia, Madagascar, Sri Lanka, Rwanda, Zambia, Portugal, Nicaragua, Central African Republic, Saudi Arabia, Panama, Israel, Gabon, Lesotho, Bhutan, Comoros
2	U-Shape	Brazil, Pakistan, Poland, Malaysia, Burkina Faso, Mali, Kenya, Paraguay, Colombia, Chad, Zimbabwe, Bolivia, Ecuador, Sierra Leone, El Salvador, Switzerland
3	Linearly increase	Thailand, Chile, Dominican Republic, Liberia
4	Not significant	Nigeria, Niger, Ethiopia, Sudan (former), Tanzania, Côte d'Ivoire, Ghana, Cameroon, South Africa, Angola, Malawi, Guinea, Peru, Bulgaria, Senegal, Guatemala, Venezuela, Togo, Lao Peoples Democratic Republic, Burundi, Yemen, Honduras, Papua New Guinea, Guinea-Bissau, Gambia, Namibia, Norway, Congo, New Zealand, Lebanon, Mongolia, Guyana, Jordan, United Arab Emirates, Botswana
5	Negative N surplus	Algeria, Benin
6	Not available	FSU, Argentina, Myanmar, Yugoslav SFR, Cambodia, Afghanistan, Iraq, Democratic Peoples Republic of Korea, Czech Republic, Lithuania, Haiti, Slovakia, Somalia, Libya, Latvia, Eritrea, Belgium, Estonia, Ireland, Timor-Leste, Jamaica, Occupied Palestinian Territory, Vanuatu, Solomon Islands, Equatorial Guinea, Belize, Cyprus, Mauritius, Suriname, Cape Verde, Oman, Puerto Rico, Réunion, Sao Tome and Principe, Samoa, Luxembourg, Trinidad and Tobago, Kiribati, French Polynesia, Tonga, Guadeloupe, Dominica, Micronesia, Martinique, Saint Vincent and the Grenadines, French Guiana, Brunei Darussalam, Kuwait, Malta, New Caledonia, Djibouti, Saint Lucia, Guam, Barbados, Grenada, Bahamas, Marshall Islands, Wallis and Futuna Islands, American Samoa, Qatar, Niue, Maldives, Bahrain, Western Sahara, Antigua and Barbuda, Seychelles, Tuvalu, Cook Islands, Singapore, Saint Kitts and Nevis, Iceland, Tokelau, Nauru, Montserrat, Bermuda, Cayman Islands, Faroe Islands, British Virgin Islands, Saint Pierre and Miquelon

Table 2 | Country groups defined according to the relationship between N surplus and GDP per capita.

3 Results and Discussions

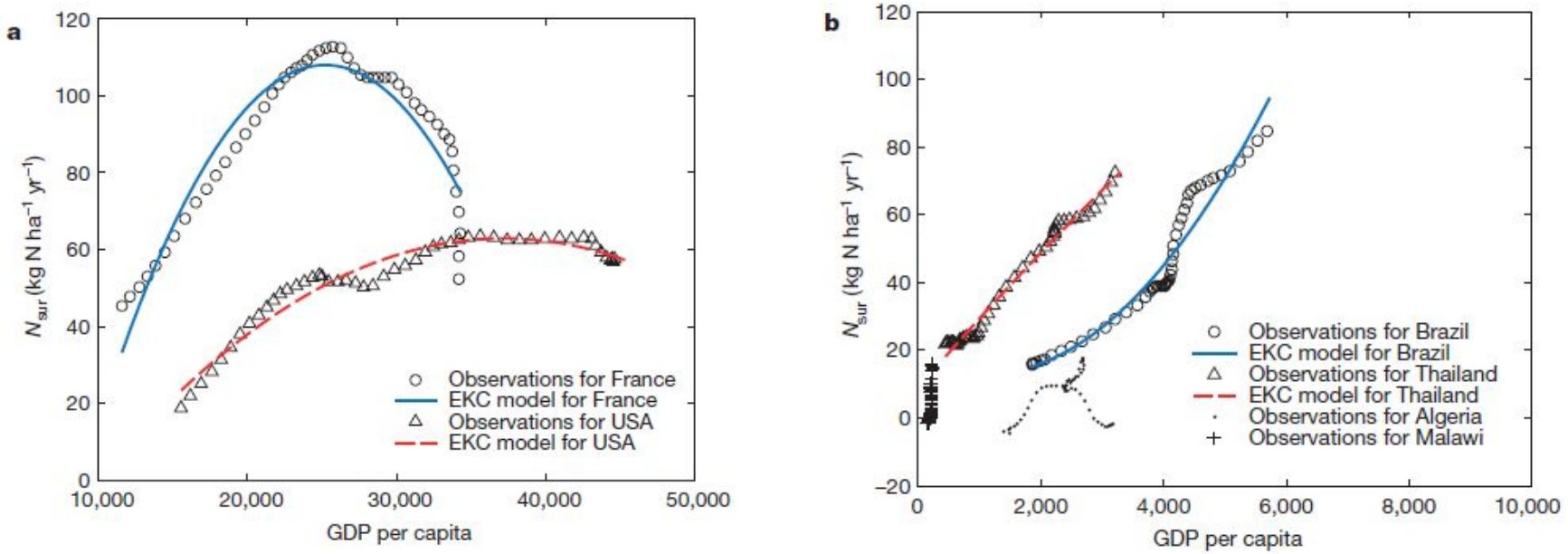

Figure 4 | Examples of historical trends of the relationship between GDP per capita and Nsur.

3 Results and Discussions

3.3Importance of crop mix

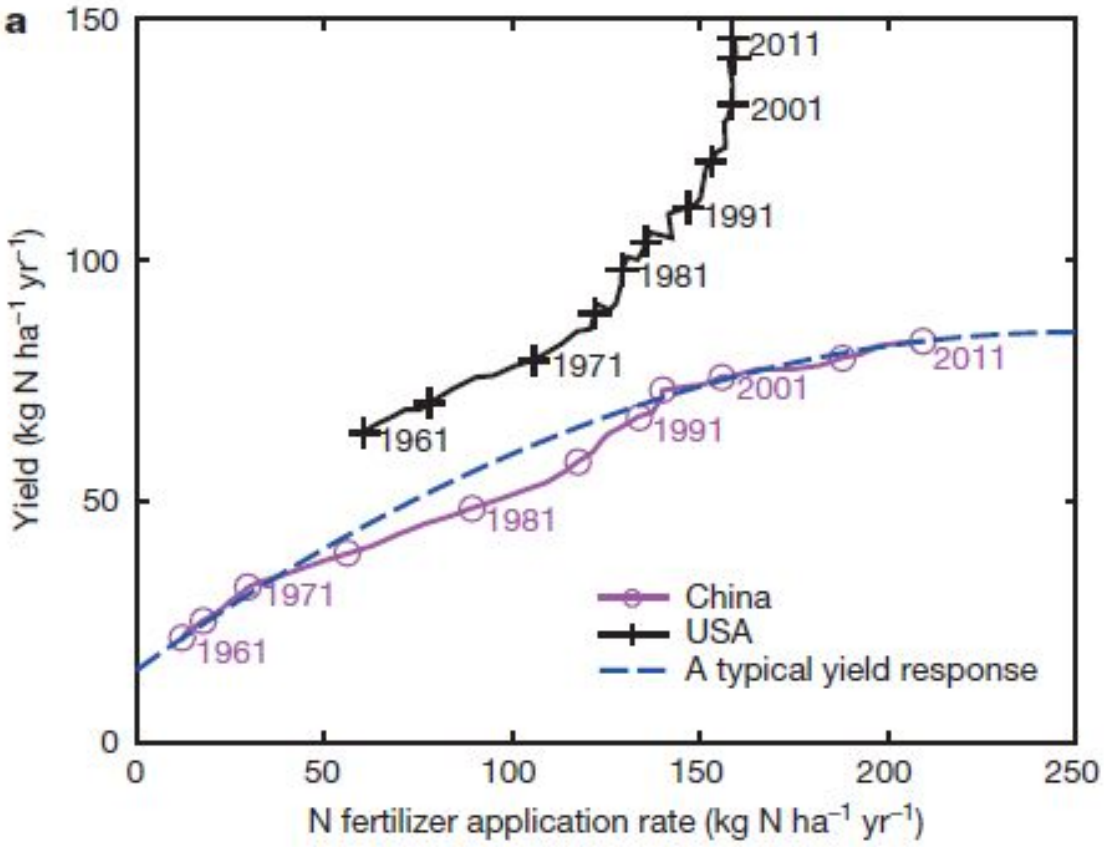

Figure 5 | Nationally averaged annual fertilization rates and yields of maize in China and the USA.

3 Results and Discussions

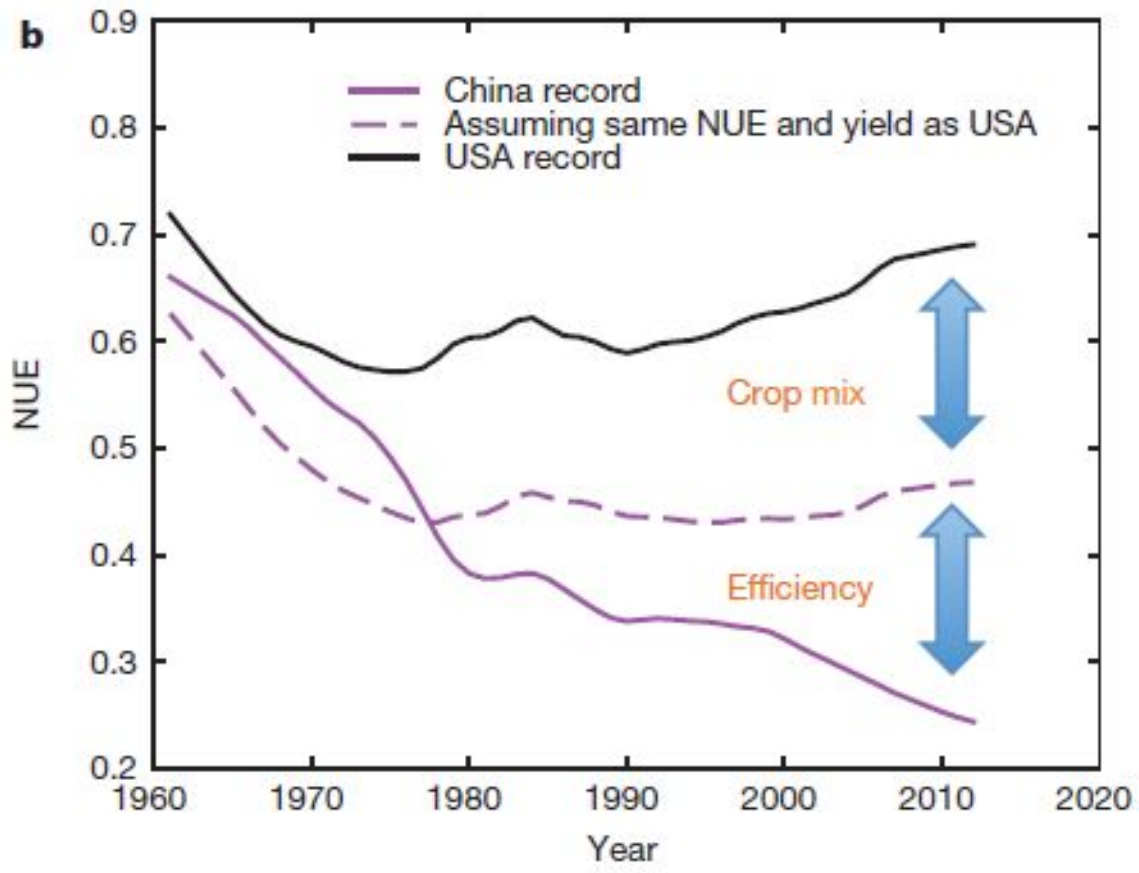

Figure 6 | NUE averaged across crops in China and the USA.

3 Results and Discussions

3.4 Fertilizer to crop price ratios

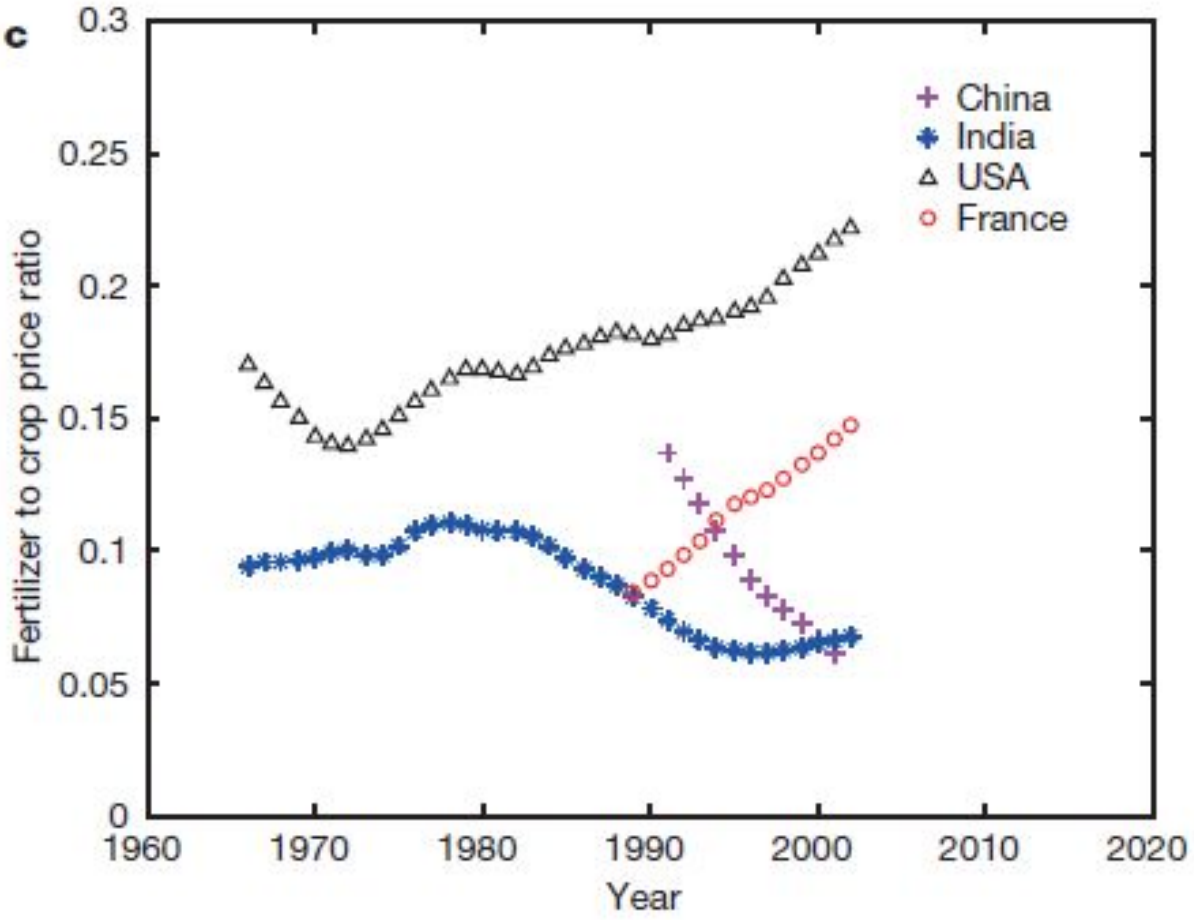

Figure 7 | Fertilizer to crop price ratios for China, India, USA and France.

3 Results and Discussions

Table 4 | N budget and NUE in crop production by region and crop in 2010 and projected for 2050.

	Current (2010)				Projected (2050)			
	Harvest N ($Tg\ N\ yr^{-1}$)	Input N ($Tg\ N\ yr^{-1}$)	NUE	Surplus N ($Tg\ N\ yr^{-1}$)	Projected harvest N* ($Tg\ N\ yr^{-1}$)	Target NUE	Required input N ($Tg\ N\ yr^{-1}$)	Resulting surplus N ($Tg\ N\ yr^{-1}$)
By region†								
China	13	51	0.25	38	16	0.60	27	11
India	8	25	0.30	18	11	0.60	19	8
USA and Canada	14	21	0.68	7	19	0.75	25	6
Europe	7	14	0.52	7	10	0.75	13	3
Former Soviet Union	4	6	0.56	3	6	0.70	8	2
Brazil	6	11	0.53	5	10	0.70	15	4
Latin America (except Brazil)	7	12	0.52	6	10	0.70	15	4
Middle East and North Africa	3	5	0.48	3	4	0.70	5	2
Sub-Saharan Africa	4	5	0.72	2	9	0.70	13	4
Other OECD countries	1	2	0.52	1	2	0.70	2	1
Other Asian countries	8	19	0.41	11	10	0.60	17	7
Total	74	174	0.42	100	107	0.67	160	52
By crop type‡								
Wheat	13	30	0.42	17	18	0.70	25	8
Rice	11	29	0.39	18	14	0.60	23	9
Maize	13	28	0.46	15	19	0.70	28	8
Other cereal crops	5	9	0.53	4	7	0.70	11	3
Soybean	16	20	0.80	4	24	0.85	28	4
Oil palm	1	1	0.46	1	1	0.70	2	1
Other oil seed	4	10	0.43	6	8	0.70	11	3
Cotton	2	5	0.37	3	3	0.70	5	1
Sugar crops	1	5	0.19	4	2	0.40	4	2
Fruits and vegetables	3	25	0.14	21	5	0.40	11	7
Other crops	5	11	0.41	7	7	0.70	10	3
Total	74	174	0.42	100	107	0.68	157	50

3 Results and Discussions

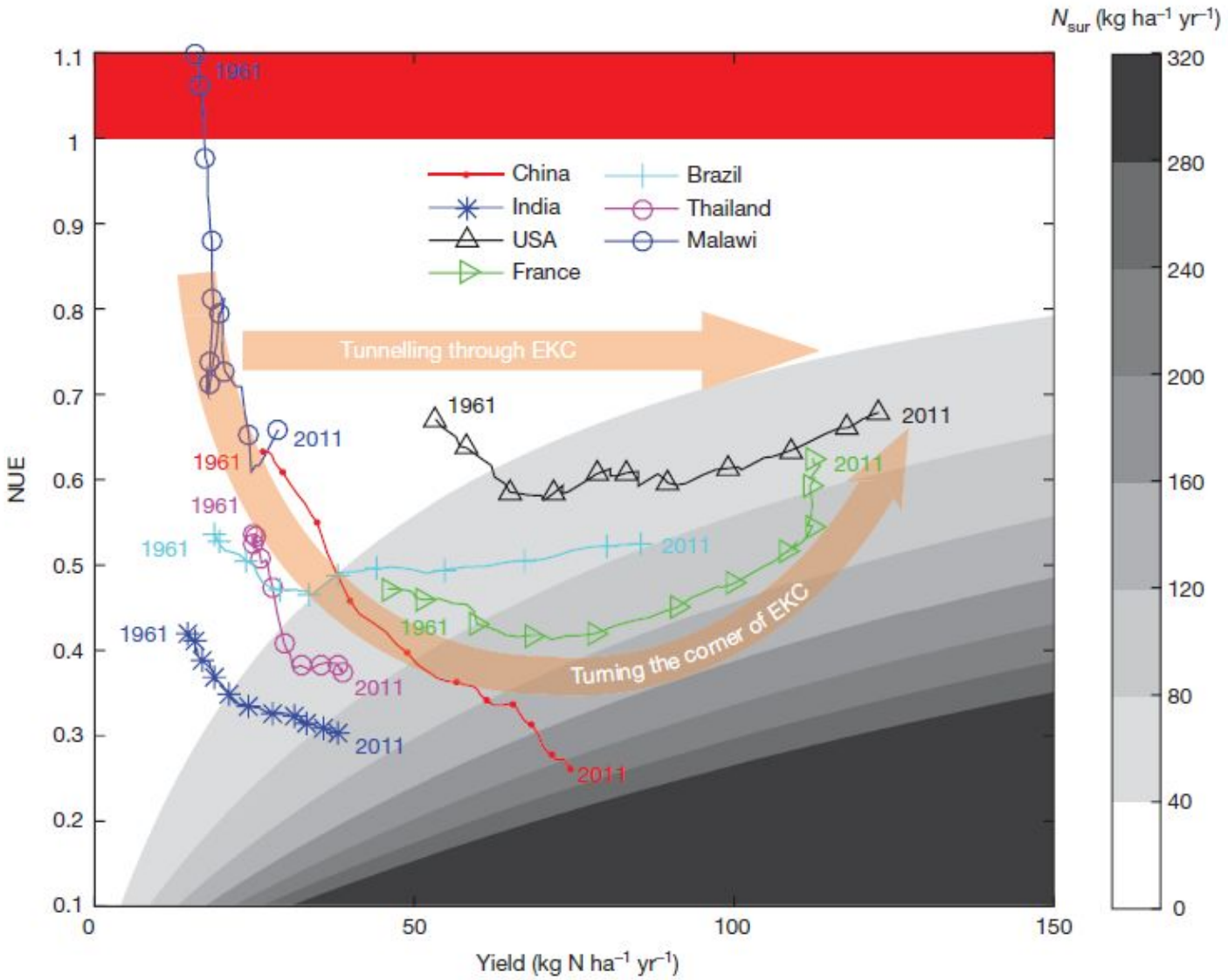

Figure 8 | Historical trends of Nyield, NUE and Nsur, for a sample of countries examined in this study.

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4 Conclusions

- N use efficiency was proposed for evaluating sustainable development goals an index of the progress and application in crop yield and other soil health parameters of sustainability of agricultural development.
- The main factors affecting the EKC NUE is crop mix and fertilizer to crop price ratios.
- Reduced N pollution in EKC mode and improve the efficiency of agricultural production is going on in the deteriorating environment a hope.
- Solved these problems still have to depend on agriculture, economy, environment, education and trade policies, these factors will largely determine the future of food and agricultural pollution emissions.

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Thank you for your attention!