

Indo-German Conference on Rural-Urban Transitions

01.02.-03.02.2023

North Block Auditorium, University of Agricultural Sciences

GKVK Campus, Bengaluru 560065, India



Indo-German Project FOR2432 Programme and Book of Abstracts



Deutsche
Forschungsgemeinschaft
DFG

**U N I K A S S E L
V E R S I T Ä T**



Georg-August-Universität
Göttingen



Indo-German Conference on Rural-Urban Transitions, 01.02.-03.02.2023

North Block Auditorium, University of Agricultural Sciences, GKVK Campus, Bengaluru 560065, India

The first Indo-German Conference on Rural-Urban Transitions in February 2019 had presented intermediate results of the joint research by Indian and German partners in the Research Unit FOR2432. It showcased research approaches from different disciplinary perspectives, and the merit of interdisciplinary integration in understanding complex transformation processes. After a second phase of collaborative research, the second Indo-German conference in 2023 will present the scientific progress and knowledge gained in the field of rural-urban transformations. While on one hand, it concludes the Indo-German Project framework of FOR2432, it will at the same time reveal new perspectives for future research.

Acknowledgements

The Indo-German Project is jointly funded by Deutsche Forschungsgemeinschaft (DFG), Germany, and Department of Biotechnology (DBT), Government of India. Funding of this conference as part of the coordination tasks is gratefully acknowledged.

Germany:

Social-Ecological Systems in the Indian Rural-Urban Interface: Functions, Scales, and Dynamics of Transition

Coordinating Universities:

Georg-August-Universität Göttingen & Universität Kassel

Spokespersons: Prof. Dr. Stephan von Cramon & Prof. Dr. Andreas Buerkert

India:

The Rural-Urban Interface of Bangalore: A Space of Transitions in Agriculture, Economics, and Society

Coordinator: Prof. Dr. K.B. Umesh

Partner institutions:

UASB - University of Agricultural Sciences, Bangalore (Coordination)

NIANP - National Institute of Animal Nutrition and Physiology, Bangalore

ATREE - Ashoka Trust for Research in Ecology and the Environment, Bangalore

ISEC - Institute for Social and Economic Change, Bangalore

IIST - Indian Institute of Space Science and Technology, Trivandrum

IWST - Institute of Wood Science and Technology, Bangalore

APU - Azim Premji University, Bangalore

IIFM – Indian Institute of Forest Management, Bhopal

Conference Office

The Book of Abstracts was compiled by the members of the FOR2432 Conference Office:

Dr. Anjali Katiganere Purushotham, Georg-August-Universität Göttingen, Germany

Dr. Veerabhadra Bellundagi, University of Agricultural Sciences Bangalore, India

Dr. Prem Jose Vazhacharickal, Rural-Urban Center, Bangalore, India

Dr. Ellen Hoffmann, Universität Kassel, Germany

Disclaimer: The authors take sole responsibility for the content of their abstracts. In case of any questions pertaining to a specific abstract please contact the respective corresponding author directly.

Indo-German Conference on Rural-Urban Transitions, 01.02.-03.02.2023

North Block Auditorium, University of Agricultural Sciences, GKV Campus, Bengaluru 560065, India

Programme**Wednesday, 01.02.2023**

Time	ID	Title	Presenter
09:30		<i>Inaugural session – Opening address</i>	Umesh K.B.
10:15	K1	<i>Introductory keynote: What caused the decline of flourishing urban complexes? Lessons from history</i>	Ganeshaiah K.N.
Session 1		Rural-urban dynamics in production systems and livelihoods <i>Chairpersons:</i> B.V. Chinnappa Reddy, Andreas Buerkert	
		<i>Oral Presentations</i>	
10:50	S1-1	Urbanisation ushering into occupational diversity: A case of the rural-urban interface of Bengaluru	Udaykumar M.S.
11:10	S1-2	Adoption of sustainable agricultural practices in the rural-urban interface of Bengaluru	Verena Preusse
11:30		<i>Coffee</i>	
11:50	S1-3	Potential impacts of urbanisation processes on dairy cattle health: Insights from Greater Bengaluru	Shahin Alam
12:10	S1-4	Effects of urbanisation on sheep value chains along the North and South transects of Bengaluru	Girish M.R.
12:30	S1-5	Backyard poultry rearing for sustainable livelihood security in the North and South transects of Bengaluru	Mamatha Girish
12:50		<i>Posters</i>	
	P1-1	Livelihood diversification of farmers	Lakshminarayan M.T.
	P1-2	Supplying fresh vegetables to the supermarkets of Bangalore - Collection centers and their impact on farmers	Dhanush K.M.
	P1-3	The story of common beans (<i>Phaseolus vulgaris</i>) in and around Bengaluru	Vidya P.S.
	P1-4	Dairy farming practices in industrial areas of North and South Bengaluru	Bhattar A.V.K.
13:15		<i>Lunch</i>	
Session 2		Land and water use in rural-urban transitions <i>Chairpersons:</i> C.T. Subbarayappa, Stephan Peth	
14:30	K2	<i>Keynote: Constructed wetland management in urban catchments for mitigating floods</i>	Ankit Agarwal
		<i>Oral Presentations</i>	
15:20	S2-1	Analysis of characteristics and spatial patterns of agricultural landscapes in a urban-rural gradient	Jayan Wijesingha
15:40	S2-2	Assessment of land suitability for selected fruit crops in Karanalu village, Northern transect of Bangalore	G.S. Jagadeesha
16:00	S2-3	What borewells tell us about the state of Bengaluru's groundwater system	Tejas Kulkarni
16:20		<i>Coffee</i>	

16:40	S2-4	Modeling effects of Nitrogen fertilization intensity and irrigation on field water cycles and water use efficiency in Bengaluru, India	Albara Almawazreh
17:00	S2-5	Soil respiration under different Nitrogen fertilization and irrigation regimes in Bengaluru, India	Suman Kumar Sourav
17:20		<i>Posters</i>	
	P2-1	Assessment of surface water quality along agro-ecosystems of rural and transitional areas of Bengaluru	Uday Kumar S.N.
	P2-2	Nitrogen dynamics in different land use systems of the Northern transect of Bengaluru	Subbarayappa C.T.
	P2-3	Transferability of remote sensing-based leaf area index prediction models to practical farm fields in Bengaluru's urban-rural interface, India	Jayan Wijesingha
	P2-4	Incorporating urbanisation impacts on hydrological processes: Application of SWAT model on the Thippa-Gondanahalli Reservoir, adjacent to Bengaluru, India.	Tejas Kulkarni
18:00		<i>End of programme / time for networking</i>	
18:30		<i>Closing</i>	

Thursday, 02.02.2023

Time	ID	Title	Presenter
09:00		<i>Welcome</i>	
Session 3		Rural-urban dynamics in ecosystem service provisions <i>Chairpersons:</i> Raghavendra Bhatta, Matthias Gassmann	
09:10	K3	<i>Keynote:</i> Ecological functions and ecosystem services in emerging urban landscapes	Asmita Sengupta
		<i>Oral Presentations</i>	
10:00	S3-1	Effect of landscape structure on bee communities in Bengaluru	Chethana V. Casiker
10:20	S3-2	Eroding socio-ecological benefits of field margin vegetation: A case study on a jeopardized component of agro-ecosystems in the transitional landscape of Bengaluru	Umesh Babu M.S.
10:40	S3-3	Changing dynamics of ecosystem service uses from an urban protected area: The case of Bannerghatta National Park in the Bengaluru Metropolitan Region	Sarang K.T.
11:00		<i>Coffee</i>	
11:20	S3-4	Screening for pesticide residues in feed and fodder samples from dairy farming systems in four industrial areas of Bengaluru	Siddharth Biswas
11:40	S3-5	Physiological and hematological responses of crossbred dairy cows in Bengaluru to climatic stressors	Silpa M.V.
12:00	S3-6	The estimation of environmental efficiency based on methane emissions in dairy production	Yashree Mehta

12:20		<i>Posters</i>	
	P3-1	Changing values of ecosystem services from mango plantations across a gradient of urbanisation: A case study from Bengaluru	Jagadishakumara B.
	P3-2	Urbanisation shapes the functional diversity of bird and bee communities on farmland	Anjaharinony A.N. Rakotomalala A.
12:40		<i>Lunch</i>	
	Session 4	Lifestyles and well-being in rural-urban transitions <i>Chairpersons:</i> K. Geetha, Stephan von Cramon	
14:00	K4	<i>Keynote:</i> The changing food environment: Dietary health burden and associated challenges	Jamuna Prakash
		<i>Oral Presentations</i>	
14:50	S4-1	Utilization of information and communication technology tools by farmers	Lakshminarayan M.T.
15:10	S4-2	Empirical analysis of food security status during COVID-19 pandemic in the rural-urban interface of Bengaluru	Nayana H.N.
15:30	S4-3	Socio-economic correlates of malnutrition in the rural-urban interface of Bengaluru	Nitya Mittal
15:50	S4-4	Aspirations, cognitive function, and economic performance: An investigation among smallholder farm managers in Bengaluru	Selina Bruns
16:10		<i>Posters & Coffee</i>	
	P4-1	Food wastage among lower middle-income families across the rural-urban interface of Bengaluru	Shilpa Yatnatti
	P4-2	Nutritional status of women in the rural-urban fringe of Bengaluru	Ashwini B.C.
	P4-3	Nutritional status of lower middle-income preschool children across the rural-urban interface of Bengaluru	Shilpa Yatnatti
	P4-4	Footprint of irrigation on farmers food security in the vicinity of Bengaluru	Hamsa K.R.
	P4-5	Urban sprawl and food security: A case of the rural-urban interface of Bengaluru	Udaykumar M.S.
16:30	K5	<i>Keynote:</i> The development of agricultural prices – short-run shocks, long-run trends and implications	Stephan von Cramon-Taubadel
17:00		<i>End of programme / time for networking</i>	
18:30		<i>Evening event:</i> <i>Reception</i>	
19:00		Special session <i>Chairperson:</i> K.B. Umesh	
	K6	<i>Keynote:</i> Urbanisation and climate change: Two imperatives for the 21st century	Karen Seto
20:00		<i>Conference dinner</i>	
22:00		<i>Closing</i>	

Friday, 03.02.2023

Time	ID	Title	Presenter
09:00		<i>Welcome</i>	
Session 5		Research networks and future perspectives <i>Chairpersons:</i> K.N. Ganeshaiah, Michael Wachendorf	
09:10	K7	<i>Keynote: History and future of rural-urban transitions</i>	Andreas Buerkert
		<i>Oral Presentations</i>	
10:00	S5-1	Trees in Bengaluru: Some illustrations of remote sensing support and spatial analyses in FOR2432	Christoph Kleinn
10:20	S5-2	Rural neglect, peri-urbanisation, and the development of <i>rurbanity</i> in Casablanca, Morocco	Hassan Rhinane
10:40	S5-3	Crossing conceptual boundaries for sustainable livelihoods in Accra, Ghana	Martin Oteng-Ababio
11:00		<i>Coffee</i>	
11:20	S5-4	Urban-rural interactions in desert lands: The camel chain in Zagora and Guelmim, Morocco	Taha Lahrech
11:40		<i>Panel discussion:</i> Reflecting narratives of global trajectories <i>Moderation:</i> Ellen Hoffmann	Karen Seto Andreas Bürkert Soubadra Devy M. Oteng-Ababio Taha Lahrech Nitya Mittal
13:15		<i>Closing remarks</i>	Umesh K.B.
13:30		<i>Internationalization in academic education</i>	Elizabeth Songate
13:40		<i>Closing remarks</i>	Umesh K.B.
14:00		<i>Lunch snacks / Informal post-conference exchange</i>	
16:00		<i>Closing</i>	

Keynote and guest speakers

Dr. K.N. Ganeshaiah, retired as the Dean of Post Graduate Studies, University of Agricultural Sciences (UAS), GKVK Bengaluru, is now at the Department of Genetics and Plant Breeding, UAS, as Indian National Science Academy Senior Scientist. He has been working in the area evolutionary ecology of plants and insects, mapping and assessing biodiversity and has been building databases on Indian Bioresources. He is interested in the historical analysis of the role of biological resources in the emergence and growth of human civilizations. He also indulges in writing novels, short stories and columns in local language (Kannada) especially in the area of history and science. Dr. Ganeshaiah is a fellow of Indian Academy of Sciences Bengaluru, Fellow of Indian National Science Academy, New Delhi, Fellow of National Association of Agricultural Scientists, New Delhi, Fellow of Current Science Association and a Fulbright Fellow.



Keynote 1 - What caused the decline of flourishing urban complexes? Lessons from history
01.02.2023 (10:15)

Dr. Ankit Agarwal is an Assistant Professor at the Department of Hydrology, IIT Roorkee, India, also affiliated with Helmholtz Centre for Geoscience (GFZ), Section 4.4 Hydrology, Germany, as a visiting scientist. He is a hydro-climatologist interested in interdisciplinary research and teaching. His research aims to understand multi-scale interactions between different components of the atmosphere and hydrosphere, and in particular between climate patterns and extreme events. Dr. Agarwal is currently serving as an editor in many well-known journals such as Scientist Reports-Nature, Journal of Hydrology, American Meteorological Society, Hydrological Science Journal, and European Physics Journal-B. Dr. Agarwal has been awarded the SYSTA Award 2022 by the International Association of Hydrological Sciences and the 2023 Division Outstanding Early Career Scientist Award of the European Geoscience Union (EGU).



Keynote 2 - Constructed wetland management in urban catchments for mitigating floods
01.02.2023 (14:30)

Dr. Asmita Sengupta is a Fellow at the SM Sehgal Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bengaluru, India. Her research interests include human-wildlife interactions, plant-animal interactions, and primate behavioural ecology. She is a National Postdoctoral Fellowship and a DST-INSPIRE Faculty Fellowship awardee. She is currently a Fellow for the Transformative Change Assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).



Keynote 3 - Ecological functions and ecosystem services in emerging urban landscapes
02.02.2023 (09:10)

Dr. Jamuna Prakash, a former Professor at Department of Food Science and Nutrition, University of Mysore, India, has a vast teaching and research experience. She is a Fellow of the International Academy of Food Science and Technology, Canada, and the National Academy of Agricultural Sciences, India. She served as visiting professor at many universities. At present, she is Adjunct Professor at MLC University, Shillong. She has had an exemplary academic career with many awards and accolades to her credit. She is actively involved in research and has served on the editorial boards of several journals. She was recognized by Stanford University as one of the top 2% scientists globally in food science for the year 2021 and 2022. Dr. Prakash has completed many research and educational projects funded by different organizations and is an active consultant for food companies. She has contributed extensively to lesson plans for Distance Education Programs. A bilingual textbook on nutrition co-authored by her has been recommended as a textbook at Mekong Agricultural University, Vietnam. She is the recipient of prestigious awards, such as Dr. Rajammal Devdas Award for research in Applied Nutrition, Best Home Scientist Award, Prof. M. Vishwanathan Honour Award for research achievements, Best Teacher Award, Leela Phadnis Memorial Award, Kellogg Award for research on iron, Mohan Memorial Award, to name a few. Presently she is engaged as an editorial board member of a book series on nutritional and health aspects of traditional foods of different countries, being published by Elsevier in association with the Global Harmonization Initiative.



Keynote 4 - The changing food environment: Dietary health burden and associated challenges
02.02.2023 (14:00)

Dr. Stephan von Cramon-Taubadel is a Professor at the Department of Agricultural Economics and Rural Development at the University of Göttingen, Germany. He earned his BSc and MSc degrees in Agricultural Economics from McGill University and the University of Manitoba, respectively. He completed his doctoral degree at the University of Kiel in 1993 and accepted the Chair for Agricultural Policy in Göttingen in 1999. Prof. von Cramon's research and teaching focus first on the determinants and effects of agricultural policy in the EU but also in comparison with other countries and region of the world. In the 1990s and 2000s he worked extensively in research and policy advisory work in countries of the Former Soviet Union, especially Ukraine, Georgia and Belarus. Another main focus of his work is on the empirical analysis of market integration and price transmission processes on agricultural markets. Stephan von Cramon is Guest Professor at the University of Nanjing and the Universidad de Talca in Chile, Secretary Treasurer of the International Association of Agricultural Economists, and currently the Dean of the Faculty of Agricultural Sciences at the University of Göttingen.



Keynote 5 – The development of agricultural prices: Short-run shocks, long-run trends and implications
02.02.2023 (16:30)

Dr. Karen Seto is the Frederick C. Hixon Professor of Geography and Urbanisation Science at Yale University, New Haven, CT, USA. An urban and land change scientist, she is one of the world's leading experts on contemporary urbanisation and global change. She uses satellite remote sensing, field interviews, and modeling methods to understand how urbanisation will affect the planet, including land change, food systems, biodiversity, and climate change. She has pioneered methods to reconstruct urban land use with satellite imagery and has developed novel methods to forecast urban expansion. She has extensive fieldwork experience in Asia, especially China and India, where she has conducted research for over 20 and 10 years, respectively. Professor Seto serves on numerous national and international scientific bodies. She currently co-chairs the U.S. National Academies Climate Security Roundtable, established by the direction of Congress to help better understand and anticipate the ways climate change affects U.S. national security interests. She also co-chairs the U.S. National Academies Subcommittee on U.S.-China Scientific Engagement. She has been a coordinating lead author for the IPCC 6th and 5th Assessment Reports. From 2000 to 2008, she was a faculty at Stanford, where she held joint appointments in the Woods Institute for the Environment and the School of Earth Sciences. She has received many awards for her scientific contributions, including the Outstanding Contributions to Remote Sensing Research Award from the American Association of Geographers. Professor Seto is a member of the U.S. National Academy of Sciences, the American Academy of Arts and Sciences, the Connecticut Academy of Science and Engineering, and the American Association for the Advancement of Science. She received a Ph.D. in Geography from Boston University.



Keynote 6 - Urbanisation and climate change: Two imperatives for the 21st century
02.02.2023 (19:00)

Dr. Andreas Buerkert is Professor of Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics at University of Kassel, Germany. His research focuses on carbon and plant nutrient cycling in agroecosystems to analyse management effects on system sustainability, the role of organic amendments and mineral fertilisers on plant nutrient availability and product quality. He is also interested in nutrient acquisition by plants in marginal and intensive environments and uses non-destructive methods such as GIS-based aerial photography for the quantification of plant growth in crop-livestock systems. Andreas Buerkert is serving as (co-) speaker of the DFG-funded Research Group *"Social-Ecological Systems in the Indian Rural-Urban Interface: Functions, Scales, and Dynamics of Transition"* and leads two major interdisciplinary projects on processes governing resource use under climate change conditions and on adoption of agricultural innovations by the German Federal Ministry of Education and Research (BMBF) and the German Academic Exchange Service (DAAD).



Keynote 7 - History and future of rural-urban transitions
03.02.2023 (09:10)

Dr. Hassan Rhinane, a professor at the Faculty of Sciences Ain Chock of Hassan II University of Casablanca, is Director of the Geosciences Laboratory and Director of the GIS and Heritage Research Center affiliated with Hassan II University of Casablanca. He is a computer expert with more than 20 years of experience in remote sensing, computer programming and database management. He is a member of the African Union-funded Global Monitoring for Environment and Security (GMES) & Africa initiative, an initiative of the European Union and the European Space Agency (ESA), which aims to provide sustainable, reliable and timely environmental and security services to meet the needs of users and policy makers. His research focuses on the use of space technologies, GIS and remote sensing to model different environments, especially those related to the urban environment. He was involved in the megacities research program "Research for the sustainable development of tomorrow's megacities", a German-Moroccan collaboration funded by the German Federal Ministry of Education and Research (BMBF). Within the focus: "Energy and climate efficient structures in urban growth centers" he was a pilot project coordinator of urban agriculture in Casablanca. He now focuses on quantitative methods, based on modelling and statistical analysis coupled with BIG DATA and artificial intelligence applied to different environmental problems.



Guest lecture S5-2 – Rural neglect, peri-urbanisation, and the development of rurbanity in Casablanca, Morocco
03.02.2023 (10:20)

Dr. Martin Oteng-Ababio is a Professor of Urban Geography at the Department of Geography



and Resource Development at the University of Ghana, where he lectures and coordinates PeriPeri U, a platform for 12 African universities' partnership to reduce disaster risks. As an urban geographer, he is passionate about social justice, and his research interests span from urban studies with a specialty in policies, economy, governance, waste-induced entrepreneurship, and the problems of informality. Apart from lecturing at home and abroad, Oteng-Ababio has an excellent research and publication record. The 2022 World Scientist and University Rankings named him as the 20th top scientist at the University of Ghana and the 46th in Ghana as a whole. Over the past decade, he won several prestigious awards, such as the second prize of the Global Development Network, a Japanese Government Award for Outstanding Research on Development (2011), the Best Paper Award at the Africa Disaster Reduction Conference in South Africa (2012), and the Best Researcher Award from the School of Social Sciences, University of Ghana (2013/2014). Dr. Oteng-Ababio's article in Habitat International was awarded as highly cited research paper for the year 2016. In 2019, he won the Dean of the School of Social Sciences, Best Mentorship Award for the 2018/2019 academic year at the University of Ghana.

Guest lecture S5-3 - Crossing conceptual boundaries for sustainable livelihoods in Ghana
03.02.2023 (10:40)

Dr. Taha Lahrech is an Assistant Professor of Agricultural Economics at Hassan II Institute of



Agronomy and Veterinary Medicine (IAV). He is affiliated to the Department of Human Sciences, where he mostly works on agricultural policies, development projects and risk analysis. He has research positions such as in the Science and Technology Research Partnership for Sustainable Development Program (SATREPS) funded by the Japanese Government (JST/JICA), which aims to address global issues and lead to research outcomes with practical benefits. He is also involved in the Water and Rural Innovation in the Maghreb Territories research-development project (MASSIRE) within a Mediterranean consortium animated by CIRAD (France). As a member of the project SIRMA (Strengthening Infrastructure Risk Management in the Atlantic Area), he belongs to an international

network for research-development between several institutions from the Maghreb countries and France.

Guest lecture S5-4 - Urban-rural interactions in desert lands: The camel chain in Zagora and Guelmim, Morocco
03.02.2023 (11:20)

Book of Abstracts

Table of contents

Programme	1
Keynote and guest speakers	5
Book of Abstracts	11
K1 – What caused the decline of flourishing urban complexes? Lessons from history	14
Session 1: Rural-urban dynamics in production systems and livelihoods	15
S1-1 Urbanisation ushering into occupational diversity: A case of the rural-urban interface of Bengaluru	15
S1-2 Adoption of sustainable agricultural practices in the rural-urban interface of Bengaluru	16
S1-3 Potential impacts of urbanisation processes on dairy cattle health: Insights from Greater Bengaluru	17
S1-4 Effects of urbanisation on sheep value chains along the North and South transects of Bengaluru	18
S1-5 Backyard poultry rearing for sustainable livelihood security in the North and South transects of Bengaluru	19
P1-1 Livelihood diversification of farmers	20
P1-2 Supplying fresh vegetables to the supermarkets of Bengaluru - Collection centers and their impact on farmers	21
P1-3 The story of common beans (<i>Phaseolus vulgaris</i>) in and around Bengaluru	21
P1-4 Dairy farming practices in industrial areas of North and South Bengaluru	22
Session 2: Land and water use in rural-urban transitions	23
K2 - Constructed wetland management in urban catchments for mitigating floods	23
S2-1 Analysis of characteristics and spatial patterns of agricultural landscapes in a urban-rural gradient	24
S2-2 Assessment of land suitability for selected fruit crops in Karanalu village, Northern transect of Bengaluru	25
S2-3 What borewells tell us about the state of Bengaluru's groundwater system	26
S2-4 Modeling effects of Nitrogen fertilization intensity and irrigation on field water cycles and water use efficiency in Bengaluru, India	27
S2-5 Soil respiration under different Nitrogen fertilization and irrigation regimes in Bengaluru, India	28
P2-1 Assessment of surface water quality in agroecosystems of rural and transitional areas of Bengaluru	29
P2-2 Nitrogen dynamics in different land use systems of the Northern transect of Bengaluru	30
P2-3 Transferability of remote sensing-based leaf area index prediction models to practical farm fields in Bengaluru's urban-rural interface, India	31

P2-4 Incorporating urbanisation impacts on hydrological processes: Application of SWAT model on the Thippa-Gondanahalli Reservoir, adjacent to Bengaluru, India.....	32
Session 3: Rural-urban dynamics in ecosystem service provisions	33
K3 - Ecological functions and ecosystem services in emerging urban landscapes.....	33
S3-1 Effect of landscape structure on bee communities in Bengaluru	34
S3-2 Eroding socio-ecological benefits of field margin vegetation: A case study on a jeopardized component of agro-ecosystems in the transitional landscape of Bengaluru	35
S3-3 Changing dynamics of ecosystem service uses from an urban protected area: The case of Bannerghatta National Park in the Bengaluru Metropolitan Region.....	36
S3-4 Screening for pesticide residues in feed and fodder samples from dairy farming systems in four industrial areas of Bengaluru	37
S3-5 Physiological and hematological responses of crossbred dairy cows in Bengaluru to climatic stressors	38
S3-6 The estimation of environmental efficiency based on methane emissions in dairy production	39
P3-1 Changing values of ecosystem services from mango plantations across a gradient of urbanisation: A case study from Bengaluru.....	40
P3-2 Urbanisation shapes the functional diversity of bird and bee communities on farmland	41
Session 4: Lifestyles and well-being in rural-urban transitions	42
K4 - The changing food environment: Dietary health burden and associated challenges	42
S4-1 Utilization of information and communication technology tools by farmers.....	43
S4-2 Empirical analysis of food security status during COVID-19 pandemic in the rural-urban interface of Bengaluru	44
S4-3 Socio-economic correlates of malnutrition in the rural-urban interface of Bengaluru	45
S4-4 Aspirations, cognitive function, and economic performance: An investigation among smallholder farm managers in Bengaluru.....	46
P4-1 Food wastage among lower middle-income families across the rural-urban interface of Bengaluru	47
P4-2 Nutritional status of women in the rural-urban fringe of Bengaluru	48
P4-3 Nutritional status of lower middle-income preschool children across the rural urban interface of Bengaluru	49
P4-4 Footprint of irrigation on farmers food security in the vicinity of Bengaluru.....	50
P4-5 Urban sprawl and Food security: A case of the rural-urban interface of Bengaluru	51
K5 – The development of agricultural prices – short-run shocks, long-run trends and implications	52
Special Session	52
K6- Urbanisation and climate change: Two imperatives for the 21 st century.....	52

Session 5: Research networks and future perspectives	53
K7 - History and future of rural-urban transitions	53
S5-1 Trees in Bengaluru: Some illustrations of remote sensing support and spatial analyses in FOR2432	54
S5-2 Rural neglect, peri-urbanisation, and the development of <i>rurbanity</i> in Casablanca, Morocco	55
S5-3 Crossing conceptual boundaries for sustainable livelihoods in Accra, Ghana	56
S5-4 Urban-rural interactions in desert lands: The camel chain in Zagora and Guelmim, Morocco	57
Panel discussion: Reflecting narratives of global trajectories.....	59

K1 – Introductory keynote:**What caused the decline of flourishing urban complexes? Lessons from history****K.N. Ganeshaiah**

Department of Genetics and Plant Breeding, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

Abstract

‘Growth’ requires resources. Any system, be it biological or an inanimate object, can grow only by utilising resources from outside its space and time. Urban system, as a complex of both biological and inanimate objects, can grow and expand only by drawing resources from its surroundings; and hence, by implication, denudes the latter. But, when the source is denuded beyond a critical level, the sink, i.e. the urban system, is starved of its resources, stops growing and eventually dies. Throughout the history of human civilization, several urban complexes that expanded and flourished, eventually declined and disappeared because of such negative feedback process between the growth of cities and their very resources. This process will be illustrated using a few case studies of urban systems across the globe drawn from different time periods of human civilization. Based on these examples, specific lessons can be derived that may lead us towards a less disastrous path of urbanisation.

Session 1: Rural-urban dynamics in production systems and livelihoods

S1-1

Urbanisation ushering into occupational diversity: A case of the rural-urban interface of Bengaluru

Udaykumar M.S.^{1*}, Umesh K.B.¹, Gaddi G.M.¹

¹ Department of Agricultural Economics, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: msudaykumar94@gmail.com

Abstract

Urbanisation is not simply a matter of increasing population numbers and density, or of sprawling city geographies, but rather implies a comprehensive change from rural to urban settings in terms of social systems and economic ecosystems. Farm land is turned into real estate property, airports, bus stations, sky scrapers, bypass roads, and industrial parks. Against this backdrop, the current study was an attempt to assess how urbanisation affects occupational diversity and income of farmers in the north of Bengaluru city, whose outskirts are on the anvil of being mended into urban. The Survey Stratification Index (SSI) was used to segment the study area into three gradient areas *viz.*, urban, transitional and rural. Herfindahl Index (HI) was used to assess the occupational diversity. The results revealed that the diversification in livelihoods was correlated with the level of urbanisation. Higher occupational diversity was noticed in the urban area (0.22) followed by transitional (0.23) and rural (0.26) areas. The respondents derived income from farm, off-farm and non-farm activities. The total annual income of households was higher in the urban area (761,267 INR) followed by transitional (710,411 INR) and rural (584,598 INR) areas. Nevertheless, dependency on agriculture was evident throughout. The urbanising segment has started deriving incomes largely from off-farm and non-farm activities. In addition, even within the purview of agriculture, the urban and transition farmers have shifted towards cultivating high value and low volume commercial crops due to the high demand from urban areas. Agricultural labours have started to work at establishments in the city, own small business and enterprises, or rental business, thus adopting more urban lifestyles. Overall, urbanisation and occupational diversity were positively correlated thereby increasing the income of agrarian households. The study concludes that there is a strong need for creating awareness among households about production and occupational diversity, integrating both agriculture and allied activities so that the livelihood security of farming community can be best assured in long run.

S1-2**Adoption of sustainable agricultural practices in the rural-urban interface of Bengaluru**

Verena Preusse^{1*}, Meike Wollni¹

¹ Department of Agricultural Economics and Rural Development, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

*Corresponding author: verena.preusse@uni-goettingen.de

Abstract

Climate change poses a threat to agricultural production and farmers' livelihoods in developing countries to which they respond using various adaptation strategies. For farmers in urbanising areas, changing framework conditions arising from urban expansion and resource pressures present additional challenges for an agricultural-based livelihood. This is coupled with an increasing pressure on ecosystem services, which are, however, crucial to maintain agricultural productivity. One approach to address this tension are sustainable farming practices. In India, the adoption of such practices is low, although farmers face major pressures arising from increasing climate variability and resource depletion. This paper examines the adoption of sustainable agricultural practices among farmers in the rural-urban interface of the mega-city of Bangalore. We use panel data collected from 350 farm households in 2016 and 2019 to analyse factors that are associated with the probability of adoption and use intensity of practices for water and erosion management, integrated pest management and soil fertility management. Besides household survey data, we use sub-district-level rainfall data for several seasons to examine its influence on the likelihood of adoption. Going beyond most prior studies, we address concerns about endogeneity by employing a correlated random-effects probit model (Mundlak approach) to control for unobserved heterogeneity in time-varying variables and multivariate probit models with Mundlak approach to account for the correlation between the decision to adopt different practices. We find that overall, education and age of the main decision maker are negatively related to adoption. Knowledge about climate change, market integration, farm size and ownership of dairy cows are positively related to adoption. The provision of extension services is largely negatively related to adoption, suggesting that information currently provided to farmers promotes the intensification of agriculture rather than resource conservation. Finally, rainfall patterns seem to play an important role for farmers' adoption decision, while household location along the rural-urban gradient is not related to adoption. Policies are required that facilitate information provision and knowledge acquisition and generate incentives for farmers to increase adoption.

S1-3**Potential impacts of urbanisation processes on dairy cattle health: Insights from Greater Bengaluru**

Md Shahin Alam¹, Silpa Mullakkalparambil Velayudhan², Debpriyo Kumar Dey³, Chiamaka Adilieme¹, Pradeep Kumar Malik³, Raghavendra Bhatta³, Sven König², Eva Schlecht^{1*}

¹ Animal Husbandry in the Tropics and Subtropics, University of Kassel and Georg-August-Universität Göttingen, Witzenhausen, Hesse, Germany

² Institute of Animal Breeding and Genetics, University of Gießen, Gießen, Hesse, Germany

³ ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka, India

*Corresponding author: tropanimals@uni-kassel.de

Abstract

Maintaining animal health is integral to sustainable livestock farming and a key concern of livestock farmers. Complex urbanisation dynamics, on one hand, create a high demand for animal products, and on the other hand put enormous pressure on - arable - land for the construction of metropolitan infrastructure with negative consequences for animal feed production and housing. To explore the impact of accelerated urbanisation on the health of dairy cattle, 151 farmers from different parts of the Greater Bengaluru metropolitan area in India were individually interviewed from January to March 2020 on aspects addressing cattle management and cattle health. Questions focused on feed sources and feeding practices, daily walking distances, drinking water supply at home, housing conditions, and veterinary care. In addition, 97 samples of forages from the shores of 10 different lakes and of vegetable leftovers were collected for nutritional analysis. The survey results indicated that 60% of the interviewed farmers kept exotic crossbred cattle and were able to supply them with sufficient feed year-round. Nearly all farmers fed concentrates to their cows. Along with the use of cultivated forages such as African tall maize (*Zea mays* L.) and Napier grass and/or crop residues such as finger millet straw, 47% and 77% of the farmers occasionally or frequently used lake fodder and vegetable leftovers, respectively. Nutritionally, the collected lake fodder reflected the ingredients of high-quality pasture, but 43% of the samples contained arsenic, cadmium, chromium, and lead above the official critical threshold levels, and therefore may affect cows' health if consumed regularly. The concentration of heavy metals did not vary across different groups of lake fodder plants, but varied between the ten lakes ($P < 0.05$). Although 95% of the farmers were regularly vaccinating their cattle against foot-and-mouth disease, only 60% of the interviewees judged that their cows had a good health status. Assessing the impact of different management aspects on perceived cattle health via Logit model as well as average marginal effects application, insufficient drinking water supply, the use of lake fodder ($P < 0.05$), and high temperature inside the shed were identified as unfavorable effects. The provision of adequate shed space for cows influenced cow health in a positive way. While it remains an open question if regular feeding of lake fodder will entail critical heavy metal accumulation in animal products, farmers and farm advisors need to address these as well as other challenges of urbanisation to cattle health, such as drinking water supply and cattle housing.

S1-4**Effects of urbanisation on sheep value chains along the North and South transects of Bengaluru**

Girish M.R.^{1*}, Mamatha Girish¹, Naveena K.P.¹, Vinutha B.S.¹, Nishmitha K.¹, Pavithra K.R.¹

¹ Institute of Agribusiness Management, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: mrgirish2000@gmail.com

Abstract

The present study aimed at examining the influence of urbanisation on the structure of sheep production systems by mapping the sheep value chain, assessing the financial viability of sheep farming, analysing the marketing of sheep, and identifying the constraints in sheep rearing in two transects north and south of Bengaluru. The number of farm households practicing sheep rearing as well as the flock size had decreased in both transects over the years. In the study area, the sheep value chain was underdeveloped with very few actors, such as input suppliers, sheep rearers, butchers, and consumers. Moreover, processing and value addition, research and extension operations were limited. The total cost incurred for rearing a flock size of 40 sheep was higher in rural zones of both North transect (244,079 INR) and South transect (262,640 INR) compared to that of transition zones (224,987 INR in North transect and 245,654 INR in South transect). The cost of labour was the major component of variable cost in rural and transition zones of both transects. At 12% discount rate, the Benefit-Cost Ratio (BCR) was found to be highest in the rural zone of the South transect with a BCR of 1.71 followed by the transition zone of the South transect (1.39), transition zone of the North transect (1.16) and rural zone of the North transect (1.05). This indicates the financial viability of sheep rearing. In the study area, three channels were prevalent for marketing of sheep, viz., Channel I: Farmer – Farmer or Consumer; Channel II: Farmer – Butcher – Consumer; and Channel-III: Farmer – Trader – Butcher – Consumer. The majority (57 % in North and 42 % in South transect) of the sheep rearers sold their sheep exclusively through Channel I. The outbreak of diseases, inadequate availability of common grazing lands, and veterinary services were the major constraints faced by sheep rearers in both transects. The sheep farmers need to be organised into associations or groups in order to have greater bargaining power.

S1-5**Backyard poultry rearing for sustainable livelihood security in the North and South transects of Bengaluru**

Mamatha Girish^{1*}, Girish M.R.¹, Naveena, K.P.¹, Vinutha B.S.¹, Manish K.L.¹, Pooja Handigund¹

¹ Institute of Agribusiness Management, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka

*Corresponding author: mamathagirish2000@gmail.com

Abstract

Backyard poultry is important for livelihoods and nutritional security of rural poor in India. This study presents an economic evaluation of backyard poultry enterprises in the North and South transects of Bengaluru. The purpose of the study was to analyse the profitability, marketing, and women participation in backyard poultry enterprise. The primary data was collected from 40 backyard poultry rearers, five butchers, and five traders in each of the two transects resulting in a total sample of 80 rearers, 10 butchers, and 10 traders. The total cost per annum for rearing an average flock size of 25 birds was estimated to be higher in the North transect (9,154 INR) compared to South transect (8,692 INR), resulting in average net returns of 7,659 INR and 9,220 INR in the North and South transects, respectively. Three marketing channels were prevalent for the marketing of birds, viz. Channel I: Farmer – Consumer; Channel II: Farmer – Trader – Consumer; and Channel III: Farmer – Trader – Butcher – Consumer. About 35% of the rearers retained the birds exclusively for household consumption in both transects. Channel I was the predominant marketing channel used by 32.5% of rearers in the North transect and 27.5% of rearers in the South transect followed Channel II and Channel III. Women were significantly involved in management aspects such as supervision of chicks, feeding, watering, collection of eggs, sale of eggs, and record keeping activities of eggs collected and sold. Disease outbreak in chicks and birds, mortality of birds, and price fluctuation were the major constraints faced by the rearers in both transects. As backyard poultry rearing is profitable with significant involvement of women, the government may extend financial support for formation of farmer producer organisations or self-help groups as sustainable livelihood option in the study area.

P1-1**Livelihood diversification of farmers**

Lakshminarayan M.T.^{1*}, Shivaramu K.¹, Pankaja H.K.¹, Preethi¹

¹ Department of Agricultural Extension, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka

*Corresponding author: mtlnextn@gmail.com

Abstract

Livelihood refers to the various activities of a farmer for earning his income to meet his expenses and survive. Diversification in activities has a great potential to enhance the farmers' income. In the light of the repeated environmental, economic, and political shocks affecting rural areas of developing countries, livelihood diversification has become more attractive in many rural communities during the past years. Against this background, the present study was carried out to assess the livelihood diversification of farmers in the rural areas of two transects north and south of Bengaluru, located in the districts Bangalore Rural and Ramanagara of Karnataka state, India. Altogether, 196 farmers from 32 villages were interviewed using a pre-tested schedule. The majority of the farmers (67.3%) were involved exclusively in farm activities (including agriculture, horticulture, sericulture and animal husbandry), while a little less than one-third of the farmers (32.7%) were involved in both, farm activities and non-farm activities. The off-farm activities practiced by the farmers included petty business, labour, and service along with agriculture allied enterprises. Among farmers practicing farm activities exclusively, 46.41% were following agriculture alone in both transects, while the remaining 53.6% of the respondents were practicing agriculture in combination with horticulture, sericulture and animal husbandry enterprises. It is quite obvious that the farmers should practice the combination of on-farm and off-farm activities for their livelihood security.

P1-2**Supplying fresh vegetables to the supermarkets of Bengaluru - Collection centers and their impact on farmers**

Dhanush K.M.^{1*}, Seema Purushothaman¹

¹ School of Development, Azim Premji University, Bengaluru, Karnataka, India

*Corresponding author: dhanush.km@apu.edu.in

Abstract

The poster presents a case study that evaluates the pros and cons of Collection Centers for fresh farm produces in Doddabellapura Taluk. The study addressed the emergence of these centres under various retail chains, their ease of access for farmers, and distribution mechanisms of fresh farm produces to Bengaluru city. Collection centers serve as crucial operational structures for the supermarkets. Their widespread presence in Doddabellapura has made it easier for local farmers to access the city's consumers. The impact of collection centers on improving farm incomes is discussed.

P1-3**The story of common beans (*Phaseolus vulgaris*) in and around Bengaluru**

Vidya P.S.^{1*}, Seema Purushothaman¹

¹ School of Development, Azim Premji University, Bengaluru, Karnataka, India

*Corresponding author: vidya.s15@apu.edu.in

Abstract

The poster presents a case study about beans (*Phaseolus vulgaris* L.), an old and popular vegetable grown around the city of Bengaluru. From analysing secondary data on sales and primary data on consumer demand, beans were identified as one of the most sold and consumed fresh vegetable in Bengaluru. Looking at the cropping pattern in the market catchment of the city, Anekal Taluk was chosen for interviewing beans growers. The case study revealed the evolution of cultivation practices in response to emerging new varieties of beans available in the seed market, and emerging preferences for varying demands from the city. The study highlights how growing and changing demand from urban consumers potentially influences the agricultural practices, diversity, ecology and food safety.

P1-4**Dairy farming practices in industrial areas of North and South Bengaluru**

Ashwin V.K. Bhattar¹, Siddharth Biswas¹, Archit Mohapatra¹, Shraddha Trivedi¹, Eva Schlecht², Vaibhav Awachat¹, Shashank Gowda¹, Krishnan G¹, Anjumoni Mech¹, Dhanalakshmi H³, Pradeep Kumar Malik^{1*}, Raghavendra Bhatta¹

¹ ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka, India

² Animal Husbandry in the Tropics and Subtropics, University of Kassel and Georg-August-Universität Göttingen, Witzenhausen, Hesse, Germany

³ Department of Veterinary Parasitology, Veterinary College, Hebbal, Bengaluru, Karnataka

*Corresponding author: malikndri@gmail.com

Abstract

Due to the increasing demand for dairy products and the limited feed resources in the rural-urban interface, dairy farmers primarily use feed resources abundant and available at their doorstep, which leads to imbalanced feeding. Imbalanced feeding of dairy cattle can lead to overall low milk productivity, lower fat content, and a negative energy balance. Our study surveyed 20 villages spread across Bengaluru's four industrial areas, Jigani, Kumbalagodu, Doddaballapura, and Abbigere. It covered 48 dairy farms with a total of 302 cattle, including 159 lactating cattle. Data on morphometric characteristics, production characteristics, and feeding practices were collected. Dung, urine, and blood samples were analysed for internal parasites, ketone bodies, and biochemical parameters. Our results describe the production systems and productivity of the dairy systems emerging in these areas. In our sample, 63% (31/48) of the dairy farmers followed semi-intensive feeding practices, whereas 17 farmers (35%) produced milk under an intensive feeding system. Out of the 48 dairy farmers, only one followed the extensive feeding system. It was common practice to graze on pastures nearby the farm for 6-8 hours during the day. Feeding of dry roughage (ragi and paddy straw) was not a common practice in the study area. Dairy farmers mostly used wheat bran, semolina bran, and gram husk as by-products as they are easily available in their vicinity. The average daily milk yield of dairy cows (n = 159) was 10.14 litres, with average milk fat, lactose, and protein contents of 3.84, 5.07, and 3.51%, respectively. The milk available after household consumption was either directly sold in the neighbourhood or to the government-authorized collection centres. From 235 collected dung samples, about 21.2% (50) contained intestinal parasites of the groups of *intestinal nematodes and parasites*. The energy status of the dairy cattle as assessed by the ketone body analysis revealed that 9.5% of the dairy cattle were in negative energy balance. The average concentration of total volatile fatty acids, acetate, propionate, and butyrate in the ruminal fluid was 100.08, 65.6, 18.4, and 12.1 mmol, respectively. The average methane yield assessed through volatile fatty acids concentration was 22.4 g/kg dry matter intake of feed.

Session 2: Land and water use in rural-urban transitions

K2 - Constructed wetland management in urban catchments for mitigating floods

Ankit Agarwal

Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand

Abstract

Wetlands in urban ecosystems provide significant environmental benefits. In the present study, the concept of urban constructed wetland development is studied from the viewpoint of urban planning with dynamic water level orifice setting controller. For this a two-step modelling procedure is employed: First, a hybrid model is developed, by coupling a well-established two-dimensional hydrodynamic model (International River Interface Cooperative, IRIC) with a one-dimensional physically-based, distributed-parameter model (Storm Water Management Model, SWMM), to compute and map flood scenarios and to identify flood-prone areas. Subsequently, SWMM is used to simulate the water inflow to the proposed constructed wetland, which acts as a cushion for storing excess flood water. The proposed methodology is implemented on the Jahangirpuri drain catchment located in Delhi, India. Results show that the hybrid model is effective, and the simulations are in good agreement with the recorded data, which assist in detecting the flood-prone areas. Further, an estimation of the impact of the proposed constructed wetland on catchment hydrology indicates an overall reduction of 23% in flooding adjacent to the channel with a significant reduction in backflow as well as water depth in the drain. The flapgate at the outlet of the wetland helps in maintaining the desired water depth in the wetland. The outcomes of this study will assist the hydrologists and administrators in urban stormwater management and planning to mitigate the impact of floods in urban watersheds.

S2-1**Analysis of characteristics and spatial patterns of agricultural landscapes in a urban-rural gradient**

Jayan Wijesingha^{1*}, Thomas Astor¹, Sunil Nautiyal², Michael Wachendorf¹

¹Grassland Science and Renewable Plant Resources, University of Kassel, Witzenhausen, Hesse, Germany

²Centre for Ecological Economics and Natural Resources, Institute for Social and Economic Change, Bengaluru, Karnataka, India

*Corresponding author: jayan.wijesingha@uni-kassel.de

Abstract

Urbanisation is a multi-dimensional complex process which drives changes in the landscape. Globally, agricultural landscapes are the most exposed to urbanisation. Therefore, understanding spatial and temporal patterns of changes in the agricultural landscape is essential for sustainable development. To address this information gap, this study developed a workflow: a) to map agricultural land-cover, b) to recognise the spatial pattern of the agricultural land-cover along the urban-rural gradient, and c) to detect transitional agricultural landscape types in the urban-rural interface of Bengaluru, one of the most populated cities in India. Pixel-based hierarchical supervised classification was employed to map agricultural land-cover using WorldView3 satellite remote sensing data. Four herbaceous crop types (millet, maize, pulses, and cash crops) and woody plantations were mapped as agricultural land-cover. Landscape metrics-based values were utilised to identify spatial patterns of the mapped agricultural land-cover against the degree of urbanisation using the Survey Stratification Index (SSI). The data-driven, unsupervised clustering method was applied to determine the agricultural landscape types. Herbaceous crop type and woody plantation mapping resulted in 63.5 % and 89.2 % overall accuracy, respectively. Landscape pattern analysis indicated that the share of agricultural land increased from urban to rural areas, and diverse heterogeneous agricultural land-cover patterns appeared in transition regions. Moreover, field crops were dominant in rural areas, and cash crops were the primary crop type in urban regions. Woody plantation was the significant crop type in both urban and transition regions. Four agricultural landscape clusters were indicated, namely A) field crop dominant, B) diverse agriculture, C) modest agriculture, and D) few or no agriculture. As a case study, the findings suggest that urbanisation in Bengaluru has an apparent effect on the agricultural landscape. Overall, the developed workflow is repeatable and transferable to other areas and could help to characterise and compare the spatio-temporal pattern urbanising agricultural landscapes.

Published in a similar form as

Wijesingha, et. al. 2022. Features and spatial patterns of an agricultural landscape along an urban-rural gradient, PREPRINT (Version 1) available at Research Square [<https://doi.org/10.21203/rs.3.rs-2102208/v1>]

S2-2**Assessment of land suitability for selected fruit crops in Karanalu village, Northern transect of Bengaluru**

Jagadeesha G.S.^{1*}, Sathish A.¹, Venkate Gowda J.²

¹Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

²KVK-Hadonahalli, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: jaggu.agri@gmail.com

Abstract

Land evaluation is concerned with the assessment of land performance when used for specific purposes. It involves the execution and interpretation of basic surveys of climate, soils, vegetation, and other aspects in terms of the requirements for alternative forms of land use. The main purpose of land use planning is to guide decisions on land use towards efficiency and sustainability, that is utilising environmental resources to the maximum while conserving those resources for the future. A detailed land suitability assessment was carried out for five selected fruit crops, viz. banana (*Musa paradisiaca*), mango (*Magnifera indica* L.), grapes (*Vitis vinifera* L.), guava (*Psidium guajava* L.) and sapota (*Manilkara zapota* (L.) P. Royen), in Karanalu, a rural village in the Northern transect of Bengaluru. The study identified six groups of soils with similar profiles (soil series) and nine mapping units based on soil morphological, physical and chemical properties. Out of the total geographical area of 336.3 ha, 27.7 ha (8.2 %) were occupied by settlements and water bodies. By the land resource inventory, it was clear that the area had considerable variation with respect to soil texture and depth. All the cultivated land (309 ha) was highly suitable for mango, guava and sapota crops. The majority of the area (295 ha) was highly suitable and 14 ha were moderately suitable with gravel limitation for banana crop. For grapes crop, the major portion of the land (162 ha) was moderately suitable with texture limitation, a small portion of the land (4 ha) was marginally suitable with gravel limitation, and the remaining area (133 ha) was highly suitable. Thus, the data showed that most of the land in Karanalu village is suitable for cultivating these five fruit crops. With some corrective measures to texture and gravelliness, fruit crop cultivation is recommended for higher production and productivity.

S2-3**What borewells tell us about the state of Bengaluru's groundwater system**

Tejas Kulkarni^{1,2*}, Matthias Gassmann¹, Kulkarni C.M.², Vijayalaxmi Khed³, Andreas Buerkert⁴

¹ Department of Hydrology and Substance Balance, University of Kassel, Kassel, Hesse

² Kiran Consultants, Bengaluru, Karnataka

³ Department of Agricultural Economics, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

⁴ Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, University of Kassel, Witzenhausen, Hesse, Germany

*Corresponding author: tejas.kulkarni@uni-kassel.de

Abstract

Over-exploitation of groundwater in India's fastest-growing metropolis, Bengaluru, has resulted in wells being bored to unprecedented depths in the crystalline-rock aquifer. However, key questions about the sustainability of this extraction process remain unaddressed due to the complexity of monitoring. Using primary surveys, this study looks at the spatio-temporal evolution of the wells on a city scale, finding that catchments with deficient water infrastructure have deeper wells. To maintain yields, wells with depths >400 m are drilled, especially since 2000, leading to unsustainable groundwater extraction. Camera inspections in 54 wells at Electronic City in 2016 and 2017 revealed that water levels in most of the wells remained lower at depths <100 m, although some wells had deeper water levels at depths >250 m. Analysis of $\delta^{18}\text{O}$ and $\delta^2\text{H}$ signatures of groundwater samples at all depths followed the local meteoric water line indicating recent recharge. This implies that drilling deeper only increases the borehole volume and does not tap into newer water sources. Water levels in deeper wells may stabilize at lower depths, are subject to high spatial variability, density of drilling, and high connectivity in upper zones. Given the interconnectedness between shallow and deeper aquifers, our research shows that increasing borewell depths could be a good indicator for falling aquifer water levels. This study fills an important gap in peri-urban, intermediate-scale aquifer conceptualizations across different land uses and provides further evidence for the difficulties of reliable groundwater monitoring in the over-exploited hard-rock aquifers of Bengaluru city.

Published in a similar form as

Kulkarni, T., Gassmann, M., Kulkarni, C.M., Khed, V., Buerkert, A. 2022. Deep drilling for groundwater in Bengaluru, India: A case study on the city's over-exploited hard-rock aquifer system. Sustainability 13, 12149.

S2-4**Modeling effects of Nitrogen fertilization intensity and irrigation on field water cycles and water use efficiency in Bengaluru, India**

Albara Almawazreh^{1*}, Daniel Uteau¹, Andreas Buerkert², Stephan Peth¹

¹ Institute of Soil Science, Leibniz University Hannover, Hannover, Niedersachsen, Germany

² Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, University of Kassel, Witzenhausen, Hesse, Germany

*Corresponding author: albara@ifbk.uni-hannover.de

Abstract

The rapid expansion of the mega city of Bengaluru over the last decades and the associated population growth led to changes in agricultural management practices towards increased irrigation agriculture and mineral fertilizer use. This has put the water resources in the region under great pressure and led to increasing surface and groundwater depletion. As plant nutrition and water uptake are closely related, there is a need to understand how N-fertilization affects the field water cycle and water use efficiency (WUE) of common crops under limiting and non-limiting water conditions. Two on-station experiments (rainfed and irrigated) were established on a deeply weathered Nitisol at the University of Agricultural Sciences Bangalore (UASB) GKVK campus. Lablab (*Lablab purpureus* L. Sweet), finger millet (*Eleusine coracana* L.Gaertn.), and maize (*Zea mays* L.), three major crops in the region, were sown and treated with three crop-specific levels of N fertilizer (high, medium, low). A soil moisture network (SoilNet, FZ Jülich GmbH, Germany) with 216 SMT100 sensors was installed at the two sites. The recorded soil moisture at three depths (15, 40 and 70 cm) was used to calibrate and validate the HYDRUS-1D model to calculate water cycle components. The results indicate that environmental factors like plant available water as a function of soil structure, water abundance through rainfall and irrigation, and plant specific properties such as N₂-fixation and drought tolerance, modulate the impact of N fertilization on water cycle components and the corresponding WUE. For both, maize and millet crops, higher N application led to higher grain yield and increased WUE. The impact of N fertilization on water cycle components (transpiration, evaporation and deep percolation) was prominent only under rain-fed conditions, where higher transpiration, lower evaporation and percolation were associated with maize and millet crops receiving higher N levels. Our results also suggest that among the three crops, maize is the most susceptible to water stress, which inhibits its ability to utilize N. In contrast, for lablab crops a positive impact of N fertilization was observed only under limiting water conditions.

S2-5**Soil respiration under different Nitrogen fertilization and irrigation regimes in Bengaluru, India**

Suman Kumar Sourav¹, Subbarayappa C.T.², Hanumanthappa D.C.³, Mudalagiriappa⁴, Prem Jose Vazhacharickal¹, Andrea Mock¹, Mariko Ingold¹, Andreas Buerkert^{1*}

¹ Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, University of Kassel, Witzenhausen, Hesse, Germany

² Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

³ AICRP on Agroforestry, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

⁴ AICRP on Rainfed Agriculture, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: buerkert@uni-kassel.de

Abstract

Rampant urbanisation has led to increasing management intensities/practices in urban and peri-urban agriculture (UPA) which affects the soils' physical, chemical, and microbial properties. This study was conducted to investigate the effects of different levels of mineral nitrogen (N) fertilizer and irrigation on CO₂ fluxes in typical crops during the Kharif (wet) and Rabi (dry) season under the monsoonal climate of Bengaluru, S-India. To this end data were collected from Kharif 2017 to Rabi 2021 in a two-factorial split-plot, on-station experiment conducted under rainfed and irrigated conditions at University of Agricultural Sciences Bangalore (UASB). Studied were three rainfed crops maize (*Zea mays* L.), finger millet (*Eleusine coracana* Gaertn.), and lablab (*Lablab purpureus* L. Sweet) as well as irrigated cabbage (*Brassica oleracea* var. capitata), eggplant (*Solanum melongena* L.), and chili (*Capsicum annuum* L.). CO₂ emissions were determined using a Los Gatos Research (LGR) multi-gas analyser (CO₂, CH₄, NH₃ and H₂O). Measurements were conducted from 7:00 am to 11:30 am and repeated from 1:00 pm to 6:00 pm. Irrespective of irrigation, season, and crops, CO₂ flux rate during afternoon hours (0.3 to 15.1 Kg ha⁻¹ hr⁻¹) was significantly higher than during morning hours (0.1 to 8.1 Kg ha⁻¹ hr⁻¹). In the irrigated field diurnal differences in emission ranged from 1.8 to 72% while in the rainfed field it ranged from 11.0 to 128.4 %. Effects of N fertilization on CO₂ flux were significantly higher on high N plots for all the crops. However, irrespective of crops, differences of CO₂ emissions between high and low N plots were 56.4 % in the rainfed field, whereas in the irrigated field they amounted to only 12.1%. Using a linear mixed effect model for data analysis allowed to show that N fertilization always had a positive effect on CO₂ emission which was highest in rainfed crops. Effect of soil moisture on the emission was positive in rainfed crops but negative in irrigated crops. Rising soil temperature at 5 cm depth increased CO₂ emission in both experiments. The crop-specific CO₂ fluxes were independent of N fertilization under irrigation, and were consistent across years.

Presented in similar form at Tropentag 2022:

Sourav, S.K. et al. 2022. Soil respiration under different N fertilization and irrigation regimes in Bengaluru, India. In: Tielkes, E. (ed.) Tropentag 2022: Can agroecological farming feed the world? Farmers' and academia's views. Cuvillier Verlag, Göttingen, Germany.

P2-1**Assessment of surface water quality in agroecosystems of rural and transitional areas of Bengaluru**

Uday Kumar S.N.^{1*}, Krishna Murthy R.¹, Devakumar A.S.², Nagaraju N.³

¹ AICRP on STCR, Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

² Department of Forestry and Environmental Science, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

³ Department of Plant Pathology, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: udaysugatur@gmail.com

Abstract

Surface water is the most precious and limited resource available on the earth and yet it is an easily accessible natural resource that plays a major role in human life, such as for domestic use, livestock keeping, and crop irrigation. The present study was conducted in rural and transitional areas of the southern and northern transect of Bengaluru, one of the fastest-growing cities in India. Surface water samples collected from various agroecosystems at the end of October (post-monsoon and end of the Kharif season) were analysed for physicochemical properties, such as pH, electrical conductivity, total dissolved solids, turbidity, total hardness, major anions, cations, and heavy metals, which are considered critical in water quality assessment for different types of end uses. The irrigation water quality index for surface water bodies indicated that 80% of the water samples from the southern rural and transitional areas had excellent water quality, while 20% of samples from the southern transition area were in the good water quality class. In the north transect 60% of the water samples from rural areas had excellent water quality and 40% had good water quality. In the northern transition area, 40% of the water samples classified as excellent and 60% as good for crop irrigation. Thus, deteriorating trends of surface water bodies are evident in transitional and even in rural parts of Bengaluru. Due to urbanisation, food habits are changing and so are the demand for crops and the cropping patterns. Most of these crops need intensive cropping systems with high inputs. The influence of these changes is reflected in the water quality deterioration in transitional and rural zones. Since there is very limited or no cultivable land available in the urban region, transitional and rural zones are the potential regions of crop production and supply to the adjoining city of Bengaluru.

P2-2**Nitrogen dynamics in different land use systems of the Northern transect of Bengaluru**

Sreshma C.K.¹, Subbarayappa C.T.^{1*}, Narayan Hebbal¹

¹ Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences
Bangalore, Bengaluru, Karnataka, India

*Corresponding author: ctsubbarayappa@gmail.com

Abstract

A study was conducted to evaluate the nitrogen (N) dynamics in different land use systems of a rural-urban transect in N-Bangalore. Four land use systems, prevalent in rural and transitional areas of the transect, were distinguished by the major crops grown: Agriculture systems dominated by staple crops, vegetable systems, flower crops systems, and plantation systems. From each land use system, 22 surface soil samples were collected randomly and analysed for different nitrogen fractions. Significant variation in each land use system was analysed statistically. In the rural area, total nitrogen was recorded highest in the agriculture land use system (4029.46 ppm), followed by the vegetable land use system (3717.91 ppm), followed by the flowering land use system (3360.41 ppm), and recorded least in the plantation land use system (3208.55 ppm). The same trend was observed in the transitional area (3171.39, 2825.18, 2677.13 and 2238.17 ppm, for agriculture, vegetable, flower and plantation land use systems, respectively). The N fractions were higher in rural soils compared to transitional soils. Organic N was predominant, while the percentage of total N derived from inorganic N was quite modest. Among inorganic N fractions $\text{NH}_3\text{-N}$ was higher than $\text{NO}_3\text{-N}$. There was a strong correlation between total N and organic carbon concentration. Thus, this study showed that total N and the organic fraction of N depend on the soil organic matter and pH of the soil.

P2-3**Transferability of remote sensing-based leaf area index prediction models to practical farm fields in Bengaluru's urban-rural interface, India**

Jayan Wijesingha^{1*}, Damian Schulze-Brüninghoff¹, Matthias Wengert¹, Sunil Nautiyal^{2,3}, Michael Wachendorf¹

¹ Grassland Science and Renewable Plant Resources, University of Kassel, Witzenhausen, Hesse, Germany

² Centre for Ecological Economics and Natural Resources, Institute for Social and Economic Change, Bengaluru, Karnataka, India

³ GB Pant National Institute of Himalayan Environment, Almora, Uttarakhand

*Corresponding author: jayan.wijesingha@uni-kassel.de

Abstract

As world population growth and urbanisation drive landscape transformation, authorities face the challenge of establishing food security and maintaining sustainable urban and peri-urban areas. Remote sensing (RS) can be a supportive tool for decision-making by gathering detailed spatio-temporal information in both, urban and rural areas at various scales. Detecting the status of crops and potential yield information are vital for addressing food security. The leaf area index (LAI) of a crop is a valuable biophysical variable that has been successfully estimated in field trials using RS data. To go beyond the experimental field-level models, this study aimed to transfer those LAI prediction models to practical (on-farm) fields and to evaluate the efficiency of model transferability. Further, farm-level LAI values were related to the degree of urbanisation to determine the pattern of interactions between agricultural activities and urbanisation in Bengaluru, India. Using finger millet as exemplary crop, LAI estimation linear regression models developed from normalised difference vegetation index (NDVI) data collected in 2018 were validated in the following year's (2021) experimental field and on-farm field data. The validation revealed that the transferability of the empirical models trained on experimental fields was limited and had to be recalibrated by adding data to represent the year of data collection to sufficiently predict data of on-farm fields. The leave location out validation resulted in the prediction of LAI values with a normalised root mean square error (nRMSE) of 14 % and a coefficient of determination of (R^2) 0.56. Moreover, by applying the trained global model on WorldView3 image data of the identified finger millet fields it was possible to differentiate the LAI values for each on-farm field along the urban-rural transect. Along the gradient, there was a trend that LAI values increased toward the city. This confirms the hypothesis that agricultural systems closer to the urban areas have higher intensification, likely providing better yields.

P2-4**Incorporating urbanisation impacts on hydrological processes: Application of SWAT model on the Thippa-Gondanahalli Reservoir, adjacent to Bengaluru, India.**

Tejas Kulkarni^{1*}, Anaz Ahmed², Matthias Gassmann¹

¹ Department of Hydrology and Substance Balance, University of Kassel, Kassel, Hesse, Germany

² Taru Leading Edge, New Delhi, India

*Corresponding author: tejas.kulkarni@uni-kassel.de

Abstract

The Arkavathy River in South India no longer supplies water to the Thippagondanahalli Reservoir (TGR) as consistently as it previously did. Some potential causes were discussed in the literature, but an integrated assessment of the effects of several causes on the water balance using a hydrological model is missing. Thus, the goal of this study was to examine the applicability of the SWAT hydrological model using a variety of spatial model setups and to evaluate the temporal variability of streamflow data on calibrating the model. Eight models were setup in terms of spatial representation: (i) We used four different land use maps derived from Landsat satellite imagery for the years 2000, 2010, 2018 and a dynamic land use change scenario; (ii) two models that included tanks and checkdams considered as reservoirs in 29 sub-catchments and another without; and (iii) two models that included a 1 km river buffer considered as wetlands land use and another with a 500 m riverbank buffer. The model performance was evaluated using the Nash-Sutcliffe efficiency (NSE) and parameter values for the calibration period and the model was evaluated for dry and wet years/months separately. The years 2011, 2017 were not included in the calibration (2010-2018) since there was uncertainty about the reliability of the streamflow data for those years. The 2010 land use had the best NSE of 0.73, indicating that neither buffer zones nor land use maps improved model performance. Checkdams and tanks were added as reservoirs, but this reduced the model's performance to NSE of 0.14 and demonstrated the challenge of including smaller storage structures in SWAT, which only permits one reservoir or ponds (not larger than 0.2 km²) per sub-basin. Monsoon flow model efficiency in wet years (NSE 0.74) was higher than in dry years (NSE 0.58). The availability, reliability, and consistency of data on streamflow and other hydrological parameters for the TGR catchment could have had an impact on a hydrological model's performance. The calibration of model parameters was further impacted by the non-stationarity of human interventions in the catchment, such as inter-basin water transfers to the dam, the creation of buffer zones on riverbanks, and the effects of the ~400 checkdams along the course of the river. This study offers insights into the SWAT model calibration under such non-stationary conditions, incorporating improvements for spatial and temporal variability. It shows that the consideration of land use changes, checkdams and riparian buffer zones did not improve the model performance and thus might not be the major drivers of change in the last two decades.

Session 3: Rural-urban dynamics in ecosystem service provisions

K3 - Ecological functions and ecosystem services in emerging urban landscapes

Asmita Sengupta

Suri Sehgal Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment, Bengaluru, Karnataka, India

Abstract:

The World Bank has predicted that by 2050, seven out of ten people will be living in cities, and ecologists have added that over the next decade or less, all our ecosystems will be 'urban'. The urban-rural divide is thus becoming increasingly indistinct already. The ongoing rapid urbanisation can have a gamut of negative impacts on ecosystem functioning including the disruption of key plant-animal interactions such as pollination and seed dispersal. Yet many of these systems remain understudied in urban environments. Based on extant literature and our own observations, we found that urbanisation affects seed dispersal in complex ways that may not always be negative. Specific policy interventions that can be integrated with urban planning can be a cost-effective way of maintaining and/or restoring these ecosystems.

S3-1**Effect of landscape structure on bee communities in Bengaluru**

Chethana V. Casiker^{1*}, Jagadishakumara B.¹, Sunil G.M.¹, Abhishek Samrat^{1,2}, Surya B.¹, Soubadra Devy M.¹

¹ Suri Sehgal Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment, Bengaluru, Karnataka

² Center for Wildlife Studies, Bengaluru, Karnataka

*Corresponding author: chethanacasiker@atree.org

Abstract

Recent studies suggest that urban spaces have higher bee and floral richness compared to adjoining rural sites. As it has been observed that bees and other pollinators are sensitive to local habitat quality, urbanisation-induced changes in extent and quality of green spaces could drastically affect these important pollinators. Landscape structure plays a significant role in determining resource availability for bees, with factors such as connectivity and proximity dictating whether resource patches can be accessed. Patchy resource availability in an urban setting could thus be a primary determinant of bee community structure. In this context, we set out to understand the extent to which urban spaces could sustain pollinators and pollination services. In this study, we explore how landscape structure helps shape bee communities in Bengaluru city. We identified five categories of spaces within the urban mosaic: large (1-5 km² area), medium (<1 km² area), and small (<0.1 km² area) green patches, connecting corridors, and highly built settlements. We sampled bees in these environments using yellow and blue pan traps over a 48-hour time period. We collected more than 10,000 specimens across different orders, and identified about 20 morphospecies of bees. We also assessed the background vegetation at five randomly chosen transects around each site, where we recorded floral characteristics. We present an overview of our findings based on the first round of (pre-monsoon) sampling. Sustaining pollination services in the city is critical not just for improved food security via edible gardening and urban agriculture, but also for achieving sustainable urbanisation. Through this study, we hope to get a better idea of how to support pollinator populations within cities. The results of the study will facilitate planning of urban green spaces and creating bee refuges to develop cities into better pollinator habitats.

S3-2**Eroding socio-ecological benefits of field margin vegetation: A case study on a jeopardized component of agro-ecosystems in the transitional landscape of Bengaluru**

Umesh Babu M.S.¹, Sunil Nautiyal^{1,2*}, Satya Prakash¹, Mrinalini Goswami¹

¹ Centre for Ecological Economics and Natural Resources, Institute for Social and Economic Change (ISEC), Bengaluru, Karnataka, India

² GB Pant National Institute of Himalayan Environment, Almora, Uttarakhand, India

*Corresponding author: nautiyal_sunil@rediffmail.com

Abstract

Field margin vegetation (FMV) refers to the semi-natural plant community in the interface between agriculture and natural environments. FMV plays an important role in ecosystem regulation, food security, mitigation and adaptation to climate change, livelihood creation, promotion of traditional health care system, and recreation. The expansion of urban and other commercial activities is posing threats to the semi-natural plant diversity. We have undertaken a research study to understand and assess the socio-ecological benefits of FMV in a transitional landscape of Bengaluru, India. In-depth analysis was conducted in two transects north and south of Bengaluru. The transects were subdivided into three zones, categorized as urban, transitional, and rural landscapes. Each transect was analysed for the pattern of spatio-temporal change of land use and land cover using LISS IV, and for the spatio-temporal dynamics of urban ecosystem services and their contribution to maintain the ecosystem. In addition, we developed a questionnaire and collected primary data on socio-ecological benefits of FMV from 300 households, 150 in each transect. We conducted 12 focus group discussions, and identified and interviewed key knowledge holders in each region. Furthermore, we collected climate data such as temperature and rainfall for about five decades (1970-2020) from India Meteorology Department and analysed them with regard to climate change impacts on FMV. Frequent field visits at different time and phases served to observe and understand the changes in agro-ecosystems in general and FMV in particular. Our results showed that the built-up area increased by 4.4% and 10.0% in north and south transects, respectively. Plantation and forest area decreased by 6.8% and 1.3% in the north and 1.5% and 3.2% in the south transect, respectively. We observed negative changes in both supply and demand patches in both the transects. The household survey suggested that there were changes in cropping pattern, decline in yield by nearly 25%, shifting livelihood dependency from farming to non-farming, and expansion of commercial activities like residential layouts, farm houses, and small-scale industries. These changes contributed to reducing the FMV area in both the transects. This is leading to erosion of socio-ecological benefits in the area. The findings show alarming signals to semi-natural biodiversity in the region.

S3-3**Changing dynamics of ecosystem service uses from an urban protected area: The case of Bannerghatta National Park in the Bengaluru Metropolitan Region**

Sarang K.T.^{1*}, Dhanya Bhaskar¹, Samudyatha R.¹

Centre for Policy Studies, Indian Institute of Forest Management, Bhopal, Madhya Pradesh, India

*Corresponding author: sarangkt@iifmbhopal.edu.in

Abstract

Protected areas in fast urbanising landscapes of the Global South face several pressures including land use diversions, habitat connectivity loss, and pollution, despite their crucial role in providing a multitude of ecosystem services (ESS) vital for human wellbeing and urban resilience. This study assesses the temporal and spatial variations and the challenges in the use of ESS and disservices from Bannerghatta National Park (BNP), the largest natural ecosystem in the Indian megacity of Bengaluru. We conducted photo-elicitation surveys with 147 respondents in 13 villages at varying distances (villages enclosed within the park, within 1 km from BNP boundary and between 1-5 km from BNP boundary) to understand the changing community perceptions of ESS from BNP with urbanisation. Our study shows that regulating services and the cultural service of aesthetic value are the most appreciated ESS across all the three zones presently. The provisioning service of fuel wood and small timber extraction which was widely preferred in the past (20 years ago), and cultural services of recreational and religious values are no longer important. In terms of spatial differences, fuelwood extraction was a highly preferred service in the past in villages within BNP, while this service was not important for other zones in the past. Total scores for all services are significantly lower nowadays compared to the past indicating lower appreciation for ESS at present. Human-wildlife conflict is the major ecosystem disservice in the past and present across the three zones. Compared to the past, the disservices of forest fires and waste dumping are perceived more seriously at present. Villagers within the park perceived risks from elephants and leopards as the most serious challenge, while for villagers in other zones restricted access to forests following the tightening of conservation measures, was the major challenge in using the ESS from the protected area. The study highlights the need of recognising the interplay of conservation and urbanisation drivers while designing and maintaining protected areas in rapidly expanding cities.

S3-4**Screening for pesticide residues in feed and fodder samples from dairy farming systems in four industrial areas of Bengaluru**

Siddharth Biswas¹, Ashwin V.K. Bhattar¹, Archit Mohapatra¹, Shraddha Trivedi¹, Eva Schlecht², Sven König³, Pradeep Kumar Malik^{1*}, Raghavendra Bhatta¹

¹ ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka, India

² Animal Husbandry in the Tropics and Subtropics, University of Kassel and Georg-August-Universität Göttingen, Witzenhausen, Hesse, Germany

³ Institute of Animal Breeding and Genetics, University of Gießen, Gießen, Hesse, Germany

*Corresponding author: malikndri@gmail.com

Abstract

Bengaluru is one of the megacities of India, which is still expanding at high rate, creating an apparent transition zone at the rural-urban interface. Since the liberalisation of the country in the early 1990s, and with the establishment of Electronics City on the outskirts of the city, often referred to as the "Silicon Valley" of India, Bengaluru also features as a hotspot of emerging urban lifestyles. The increasing demand for raw milk and milk products in the megacity prompts dairy farmers in the periphery of the city to intensify production under very specific economic and environmental conditions, where the husbandry systems are often subject to heat stress and potentially contaminated feed resources. A systematic study was conducted in four industrial areas located at the rural-urban interface of Bengaluru (Jigani, Kumbalgodu, Doddaballapura, and Abbigere). A total of 48 dairy farms, including 25 in south Bengaluru and 23 in north Bengaluru, were repeatedly visited for the collection of production trait data, and samples of feeds and fodder. A high concentration of cortisol (54.2 ng/ml) in the blood plasma indicated that the dairy cattle were affected by heat stress, which was substantiated by an elevated HSP70 concentration (7.72 ng/ml). As pesticides are frequently used by dairy farmers in industrial areas for crop and fodder production, a total of 16 pesticides (imidachloprid, glyphosate, 2,4-D, acephate, endosulfan, aldrin, malathion, parathion, lindane, heptachlor, chlordane, chlorpyrifos, fenitrothion, phosalone, acetamiprid, and emamectin benzoate) were selected for residue analysis in the feed samples. A total of 126 out of 166 feed samples (75.9%) were found contaminated with pesticide residues. Results from the study indicated that 94.6%, 76.3%, 56.2%, and 70.8% of the feed samples were contaminated with pesticides in Jigani, Kumbalgodu, Doddaballapura, and Abbigere, respectively. The most common contaminant was chlorpyrifos (110/166), followed by malathion (29/166), glyphosate (11/166), 2,4-D (10/166), and acetamiprid (3/166). In addition, acephate and imidachloprid were also detected in one of the feed samples. The chlorpyrifos contamination was highest in Jigani (92.8%) and Abbigere (70.8%) industrial areas, whereas malathion was the most prevalent contaminant in the feeds from Doddaballapura area (31.2%).

S3-5**Physiological and hematological responses of crossbred dairy cows in Bengaluru to climatic stressors**

Silpa Mullakkalparambil Velayudhan¹, Kerstin Brügemann¹, Md Shahin Alam², Tong Yin¹, Chinnasamy Devaraj³, Veerasamy Sejian^{3,4}, Raghavendra Bhatta³, Eva Schlecht², Sven König^{1*}

¹ Institute of Animal Breeding and Genetics, University of Gießen, Gießen, Hesse, Germany

² Animal Husbandry in the Tropics and Subtropics, University of Kassel and Georg-August-Universität Göttingen, Witzenhausen, Hesse, Germany

³ ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka, India

⁴ Rajiv Gandhi Institute of Veterinary Education and Research, Pondicherry, India

* Corresponding author: sven.koenig@agrar.uni-giessen.de

Abstract

A comprehensive study was conducted to assess the effects of seasonal transition and temperature humidity index (THI) on the adaptive responses of crossbred dairy cows reared by small-scale farmers in Bengaluru, India. The research period comprised the transitioning season of summer to monsoon, wherein a number of traits were recorded from 40 lactating crossbred cows at two points, one representing late summer (June) and the other early monsoon (July). A large set of variables were assessed, representing physiological responses such as pulse rate (PR), respiration rate (RR), rectal temperature (RT), skin surface temperature (SST), haematological profile, and production traits such as test day milk yield, and milk composition. Seasonal transition had significant effects on RR, SST, mean platelet volume, platelet distribution width (PDWc), test day milk yield, and on several milk composition variables (milk density, lactose, solid-not-fats, and salts). The THI had a significant effect on RR, SST, platelet count, plateletcrit and PDWc. The results from this study reveal that novel physiological and hematological traits are sensitive to climatic stressors, thus highlighting their potential as stress biomarkers.

S3-6**The estimation of environmental efficiency based on methane emissions in dairy production**

Yashree Mehta^{1*}, Marion Reichenbach^{2,3}, Bernhard Brümmer¹, Eva Schlecht²

¹ Department of Agricultural Economics and Rural Development, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

² Animal Husbandry in the Tropics and Subtropics, University of Kassel and Georg-August-Universität Göttingen, Göttingen, Germany

³ Since 02/2022: Animal Nutrition, Eidgenössische Technische Hochschule (ETH) Zürich, Zürich, Switzerland

* Corresponding author: yashree.mehta@uni-goettingen.de

Abstract

The city of Bangalore in south India is a major hub for pollution through GHG emissions generated from livestock activity. Livestock for dairy production is reared in the rural-urban interface of Bangalore and is the main source of raw milk supply to the state dairy cooperative which sells milk and milk products under the brand name "Nandini". We assess the scope for reducing methane emissions from milk production by using panel data of milk producers from two years for 2016-17 and 2019-20. We focus on enteric fermentation and the linkage between milk production and emission intensity. We conduct an econometric application of the two-stage by-production approach to estimate the environmental efficiency of milk producers in the rural-urban interface of the city. We estimate the emission generating technology like a cost frontier and decompose the resultant inefficiency score as environmental efficiency due to technical inefficiency (from milk production) and allocative inefficiency (from incorrect proportions of emission-generating inputs). We find that environmental efficiency can be improved by changing the proportions of concentrate feed and dry non-concentrates.

P3-1**Changing values of ecosystem services from mango plantations across a gradient of urbanisation: A case study from Bengaluru**

Jagadishakumara B.^{1*}, Chethana V. Casiker¹, Sunil G.M.¹, Gabriel Marcacci², Soubadra Devy M.¹

¹ Suri Sehgal Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment, Bengaluru, Karnataka, India

² Functional Agrobiodiversity, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

*Corresponding author: jagdish.kumar@atree.org

Abstract

India is the world's largest producer and exporter of mangoes. It ranks first among the mango producing countries of the world accounting for about half of the world's mango production, followed by China and Thailand. Mango has both traditional and economical uses. Notably, mango is a crop which is dependent on pollinators for higher yields. Bangalore city and its peri-urban areas have large swathes of newly established plantations and remnants of old mango plantations. Urbanisation can impact these plantations in many ways as these areas are prone to be converted into open fields or built areas. Urbanisation can also drastically affect the flow of pollination services and other ecosystem services that are drawn from these farms. We addressed the question of whether farmers are able to perceive the importance of pollination service, and whether this awareness was derived from field knowledge or from higher education. We also examined if the other ecosystem services which include cultural services drawn from these plantations are changing along the gradient of urbanisation, the kind of values that the farmers attach to the plantations, and management practices applied along the gradient.

P3-2**Urbanisation shapes the functional diversity of bird and bee communities on farmland**

Gabriel Marcacci¹, Anjaharinony A.N.A. Rakotomalala¹, Ingo Grass², Arne Wenzel¹, Arne Wenzel¹, Varsha Raj³, Nils Nölke⁴, Vikas S. Rao³, Shabarish Kumar S⁵, K.B. Tharini³, Vasuki V. Belavadi³, Teja Tschardt^{1,6}, Catrin Westphal^{1,6}

¹Functional Agrobiodiversity, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

²Department of Ecology of Tropical Agricultural Systems, University of Hohenheim, Stuttgart, Baden Württemberg, Germany

³Agricultural Entomology, University of Agricultural Sciences, Bangalore, India

⁴Forest Inventory and Remote Sensing, Faculty of Forest Sciences and Forest Ecology, University of Göttingen, Göttingen, Niedersachsen, Germany

⁵Department of Apiculture, University of Agricultural Sciences, Bangalore, India

⁶Centre of Biodiversity and Sustainable Land Use (CBL), Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

Abstract

Understanding the impact of urbanisation is important to develop strategies for conserving biodiversity and its services to humans, yet knowledge is very limited in tropical regions. In our studies, we assessed how urbanisation affects farmland bee and bird communities in a growing megacity, Bengaluru in India. We sampled bees and recorded birds in 36 smallholder vegetable farms distributed along a gradient of urbanisation. Here, we used sealed surfaces and buildings' land cover around the farms, hereafter called "grey area", as an indicator of urbanisation intensity. We found that the overall bee abundance decreased with urbanisation. When categorized into functional groups, the abundance of larger, solitary, and cavity-nesting bees increased while social bee abundance decreased with urbanisation. We also found that flower resources within and natural or semi-natural vegetation around farms promoted and maintained a high abundance and diversity of bees. Moreover, crop diversity in the landscape promoted the taxonomic and functional diversity of bee communities. In terms of bird communities, we found that increasing amounts of grey area resulted in taxonomic and functional homogenization, with particular loss of insectivorous birds that are important for natural pest control. With urbanisation that is still ongoing in Bengaluru, our findings suggest preserving natural and semi-natural vegetation surrounding the cultivated land, and promoting crop diversification to increase flowering and nesting resources for bees. To reverse the negative impact of urbanisation on bird communities, increasing the amount and size of green areas such as urban parks would be an option to enhance bird taxonomic and functional diversity.

Published in a similar form as

Marcacci G., Grass I., Rao V.S., et al. 2022. Functional diversity of farmland bees across rural-urban landscapes in a tropical megacity. *Ecological Applications*(8), e2699.

Marcacci G., Westphal C., Wenzel A., et al. 2021. Taxonomic and functional homogenization of farmland birds along an urbanization gradient in a tropical megacity. *Global Change Biology*, 27, 4980–4994.

Session 4: Lifestyles and well-being in rural-urban transitions

K4 - The changing food environment: Dietary health burden and associated challenges

Jamuna Prakash

Department of Food Science and Nutrition, University of Mysore, Mysore, Karnataka, India

Abstract

Food environment is a significant factor affecting food choices. During the last few decades, major transitions have taken place in the food environment, characterising the dietary patterns and the consequential nutrition transition. Their influence has been both positive and negative on food and nutrition security, the agri-food systems, and health of population. With advances in science and technology and the communication systems, today's consumers are better equipped to make informed choices for healthier food options. However, the described transformation has also resulted in availability of unhealthy foods increasing the dietary health burden. Among the drivers of dietary change affordability, easy accessibility, ease of preparation, and availability of processed and convenience foods, the strongest factor influencing choice is taste and not health or nutrition. There has been a very distinct divide bringing forth the issue of nutrition equity as spelled out in Global Food and Nutrition Security Reports, divides dictated by rural and urban surroundings, food cultures, rich and poor population, lifestyle changes and literate and illiterate consumers. At present the agri-food systems do not emphasize on nutrition sensitive agriculture, and the policies are skewed towards dealing with hunger and not nutrition per se. The incidences of non-communicable diseases are increasing worldwide with ever rising number of hungry people. Anemia and micronutrient deficiencies are still prevalent across a significant number of populations demanding urgent attention. Overweight and obesity are a cause of concern not only in adults but in children too, specifically in urban areas. Healthy diets with more of protective foods are costlier in comparison with energy-rich, fat-rich, sugar laden processed products. A concerted effort is required to transform food behavior and reduce the dietary health burden with constant consumer education, industry participation and policy changes.

S4-1**Utilization of information and communication technology tools by farmers**

Lakshminarayan M.T.^{1*}, Shivaramu K.¹, Pankaja, H.K.¹, Preethi¹

¹ Department of Agricultural Extension, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka

*Corresponding author: mtlnextn@gmail.com

Abstract

Information and Communication Technology (ICT) is any device, tool, or application that permits the exchange or collection of data through interaction or transmission. It is an umbrella term that includes any communication device or application such as radio, television, cellular phones, computer and network hardware and software, satellite systems as well as the various services and applications associated with them (videoconferencing and distance learning). ICT services provide critical access to the knowledge, information, and technology that farmers require to improve agricultural productivity and the quality of their lives. Against this backdrop, the present study was carried out to estimate the extent of use of ICT tools by farmers in the rural areas of two transects north and south of Bengaluru. Within the districts Bangalore Rural and Ramanagara of Karnataka state, India, 196 farmers from 32 villages were interviewed using a pre-tested questionnaire. Television (93%) and smart phones (77%) were the ICT gadgets used by more than three-fourth of the farmers in the study region. Farmers were using software and apps like WhatsApp (53%), facebook (48%), youtube (52%) and SMS (34%) to get information on agriculture. A little over one-fifth of the farmers were using android apps related to agriculture viz., UASB e-Krishi agri portal (24%), Beeja Aadhar (24%), e-sap (22.5%) and Soil Testing Crop Response (STCR). Google chrome (40%) was the search engine used by a larger number of farmers for obtaining information related to agriculture. The results also revealed that almost an equal number of farmers were sparse (41%) or medium (40%) users, and 19% were frequent users of ICT tools. Education, land holding, annual income, material possession, innovative proneness, mass media participation, extension participation and extension agency contact of farmers were found to have significant relationship with the extent of use of ICT tools. High cost of ICT tools (68%), lack of knowledge or skill in using ICT tools (66%), interrupted power supply (59.5%), poor internet connection (58.5%) and problems of viruses and junk mails (54%) were the difficulties encountered by more than half of the farmers using ICT tools.

S4-2**Empirical analysis of food security status during COVID-19 pandemic in the rural-urban interface of Bengaluru**

Nayana H.N.^{1*}, Umesh K.B.¹, Hamsa K.R.¹, Ashwini B.C.¹, Gaddi G.M.¹, Veerabhadrapa Bellundagi¹

¹ Department of Agricultural Economics, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: nayanahnreddy1997@gmail.com

Abstract

People's livelihoods have been impacted by the COVID-19 pandemic all across the world. It has altered human habits, like food habits, working habits, spending habits, or personal care habits. The ability to alter food consumption habits was constrained by income, which has an impact on the households' access to food and nutritional security. This pandemic has resulted in job losses, food shortages, and increase in food prices and threatening the very survival of mankind. The pandemic has also reduced access, availability and affordability of food which resulted in increased food insecurity in both higher and lower-income countries. This study examined the effect of COVID-19 on food security in the rural-urban interface of Bangalore. The required primary data for the study was collected from 482 households through telephonic survey. Household Food Insecurity Access Scale (HFIAS) approach is used to estimate the prevalence of food insecurity in the study area. The study found that during COVID-19 pandemic, more than 70 % of the households were food secure across rural, transition and urban areas of both north and south transect of Bengaluru, while the percentage of food insecurity ranges from 7 to 30 % in the study area. Variables associated with food security status in rural-urban interface of Bengaluru analysed using multinomial logistic regression revealed that education, dummy for north and south transect and dummy for Covid-19 were significant. COVID-19 had a negative influence on food security status and it has increased the problem of food insecurity in the study area. Thus, the government needs to develop short-term, medium-term and long-term plans to combat such sudden outbreak of diseases and to ensure food security. These plans should include maintenance of sufficient buffer stocks with good storage facilities and storage plans to avoid wastages of foods.

S4-3**Socio-economic correlates of malnutrition in the rural-urban interface of Bengaluru**

Nitya Mittal^{1*}, Anjali Purushotham², Stephan von Cramon-Taubadel², Sebastian Vollmer¹

¹ Centre for Modern Indian Studies, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany.

² Department of Agricultural Economics and Rural Development, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

*Corresponding author: nitya.mittal@uni-goettingen.de

Abstract

Multiple burdens of malnutrition are the new reality of nutrition and health-related problems in many low- and middle-income countries. In most scenarios, multiple burdens of malnutrition coexist at the population, household, and individual levels, which bring further complexities to nutrition and health situation. We estimate the prevalence of multiple burdens of malnutrition among three demographic groups in the rural-urban interface of Bangalore. Further, we examine the socio-economic correlates of multiple burdens of malnutrition. We use the primary socio-economic survey data collected in the rural-urban interface of Bangalore between March and August 2022. We estimate the prevalence of multiple burdens of malnutrition for three demographic groups – children (below 18 years), adult males (above 18 years), and adult females (above 18 years). For each demographic group, we estimate the prevalence of undernutrition (stunting, wasting, underweight, and anemia), overnutrition (overweight, obesity, central obesity), and non-communicable diseases (diabetes, high cholesterol, and hypertension). The outcomes of this study help to identify the socioeconomic factors at the individual, household, and community levels, which can further help in designing double-duty actions that aim to simultaneously address multiple burdens of malnutrition. Particularly in the context of the rural-urban interface of Bangalore, where rural and urban characteristics merge and evolve, such double-duty actions are important to ensure the efficient allocation of resources to address malnutrition.

S4-4**Aspirations, cognitive function, and economic performance: An investigation among smallholder farm managers in Bengaluru**

Selina Bruns^{1*}, Bernhard Dalheimer¹, Oliver Musshoff¹

¹ Department of Agricultural Economics and Rural Development, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

*Corresponding author: selina.bruns@uni-goettingen.de

Abstract

One prominent strategy to lift large shares of rural populations out of poverty builds on programs aiming to sustainably increase farm productivity. While such programs have been successful in reducing poverty during recent decades, research suggests that interventions do not reach all individuals equally, resulting in robust poverty rates in some populations. Reasons for this remain opaque. While studies intensely investigated exogenous factors of farm managers, non-cognitive skills and cognitive function are just emerging as potential explanatory variables for differences in economic performances. This first evidence suggests that both cognitive function as well as non-cognitive skills appear to be key for optimal decision making in agriculture. Yet, they have only been investigated in isolation. Thus, this paper sets out to investigate the interactive effects of cognitive function and non-cognitive skills on smallholder farm productivity. Specifically, relying on 2022 data from 400 smallholder producers in Bengaluru, India, this paper (i) measures the level of cognitive function and aspirations of smallholder farmers, (ii) models the production process of farm output, (iii) estimates productivity and efficiency by means of stochastic frontier analysis, and (iv) measures the effect of cognitive function and aspirations to explain differences in economic performance. This study provides first recommendations to policy on whether an investment in pushing aspirations might be more worthwhile than accounting for or improving the level of cognitive function in order to drive productivity of smallholder farmers.

P4-1**Food wastage among lower middle-income families across the rural-urban interface of Bengaluru**

Geetha K.¹, Geetha M. Yankanchi¹, Shamshad Begum S.¹, Shilpa Yatnatti^{1*}

¹ Department of Food Science and Nutrition, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: shilpayatnatti@gmail.com

Abstract

Food wastage is a problem of global concern. According to the UN hunger report, although the world produces enough food to feed the entire global population, as many as 811 million people go hungry every day, because of food wastage. Most of this waste globally comes from households, followed by food services and retail outlets. In India it is estimated that 50 kg of food is wasted per capita per year. On this background, this study estimates the extent of food waste among lower middle-income households in rural areas in the periphery of Bengaluru. A total of 20 households belonging to the lower middle-income group in the northern and southern transect of Bengaluru were selected by purposive random sampling. Households were provided with a kitchen weighing scale and a diary to record food wastage in their household for a period of one week. Findings revealed that in the northern transect, cereals and millets (2.7 kg) were wasted more, whereas in the south transect milk and milk products (2.2 kg) wastage was higher. Irrespective of the transect, cooked food items like rice, *mudde*, and *chapathi* were wasted more followed by *sambar*. Altogether, raw and cooked food wastage in the rural areas of the northern and southern transects was 3.3 kg and 8.3 kg per household per week, respectively. Among cooked foods, lunch or dinner food items were more frequently wasted. About 60% of the households wasted it 5-7 times a week and the remaining 40% of households wasted it 2-4 times in a week. Processed foods were the least wasted foods due to their storage stability. Purchase or preparation of excess food, serving more food than required and lack of refrigeration are most common reasons for food wastage in rural areas. This shows that a substantial amount of food is wasted in rural areas. Instead, excess food must be made available to those who are in need through governmental and non-governmental organisations. Addressing the reasons for food wastage helps in preventing household food wastage. Prevention of wastage means more food available to consumers and can be a step towards achieving food security.

P4-2**Nutritional status of women in the rural-urban fringe of Bengaluru**

Ashwini B.C.^{1*}, Umesh K.B.¹, Nayana H.N.¹, Hamsa K.R.¹, Gaddi G.M.¹, Veerabhadrappe Bellundagi¹

¹Department of Agricultural Economics, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: ashwinismile813@gmail.com

Abstract

According to the State of Food Security and Nutrition in the World, 2020 report, 14% of India's population is undernourished. With more than 50% of the population being women and adolescent girls, their nutritional status is crucial for their own wellbeing as well as their future offspring. At the state and national level, the extent of under nutrition among urban men and women was nearly identical. The extent of prevalence of under nutrition among men and women in rural Karnataka was 16.7% and 20.7%, respectively. In the past two decades, the mean Body Mass Index (BMI) has increased globally. With this background, the present study estimates the nutritional status of women across rural-urban interface of Bangalore. The study uses primary data collected from 792 women respondents across the rural-urban interface of Bangalore. The classification of nutritional status of women was based on BMI. Findings of the study indicated that, in the northern transect of Bangalore the percentage of underweight women was higher in rural (20.3%), while that of overweight and obese women was higher in urban and transitional areas (30.4% and 15.9%, respectively). Whereas, in the southern transect of Bangalore, the percentage of underweight women was more in rural (19.4%), overweight (33.3%) was more in urban, and obese (16.7%) was more in transitional areas. The percentage of overweight and obese women was higher in the north and south transects of Bangalore than the percentage of women who are underweight. From the policy perspective, it is important to promote public health programs to create awareness about the harmful effects of sedentary lifestyles.

P4-3**Nutritional status of lower middle-income preschool children across the rural urban interface of Bengaluru**

Shilpa Yatnatti^{1*}, Geetha K.¹, Geetha M. Yankanchi¹, Shamshad Begum S.¹

¹ Department of Food Science and Nutrition, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: shilpayatnatti@gmail.com

Abstract

Nutritional status is the condition of the body as a result of the intake, absorption and use of nutrients, as well as the influence of disease-related factors. Nutritional status of vulnerable groups such as children is an important public health concern. Preschool age is the important stage of human life cycle and nutritional status during this stage greatly influences health during later stages of life. Bangalore is a rapidly urbanising south Indian mega city and it is important to study the effect of its urban environment on the nutritional status of people in the surrounding localities. With this background, this study was conducted to assess nutritional status of preschool children across the rural-urban interface of Bangalore. A total of 100 preschool children were selected from identified localities within the north and south transects of Bangalore belonging to lower middle-income families. Anthropometric parameters such as, height, weight, head circumference, MUAC (mid upper arm circumference), and triceps skinfold thickness were measured. Indices such as weight for age, height-for-age and BMI-for-age were calculated through WHO anthro app. Underweight (14%) and stunting (14%) were higher among boys compared to girls. In northern transect, underweight among preschool children was 12% and stunting was 14% irrespective of gender. In southern transect, underweight was more prevalent among boys (22%) compared to girls (9%). Stunting was 4.3% and 3.7% among girls and boys respectively. Surprisingly, 13% of girls were overweight, whereas it was only 4% among boys. Irrespective of gender, 16% of children were underweight, 4% of them were stunted and 8% of them were overweight in southern transect. Government intervention programmes along with nutritional education to the parents is the current need to correct nutritional problems at this stage for future healthy adults.

P4-4**Footprint of irrigation on farmers food security in the vicinity of Bengaluru**

Hamsa K.R.^{1*}, Umesh K.B.¹, Ashwini B.C.¹, Nayana, H.N.¹, Gaddi G.M.¹, Veerabhadrappe Bellundagi¹

¹ Department of Agricultural Economics, University of Agricultural Sciences Bangalore, Bengaluru, Karnataka, India

*Corresponding author: hmmshamsa@gmail.com

Abstract

Over the past decades agricultural production and per capita availability of food grains has increased in India, but the country is still depending on imports of many food items. To reduce these imports, domestic production has to increase. For increasing the agricultural production there is a need for improved technology, and efficient utilization of resources. In the present context we focus on irrigation as crucial input for increasing food security through intensified and diversified agricultural production. The main source of irrigation in India is groundwater which supplies 70% of the total irrigated area. Groundwater resources are vital both for irrigation and drinking water in India. With the use of scarce groundwater, achieving both food and nutritional security are crucial. In this framework, the study aims to assess the impact of irrigation on food security. The study is based on primary data collected from 498 households (irrigated and rainfed) in the rural-urban interface of Bangalore (north and south transect). The Household Food Insecurity Access Scale (HFIAS) method was used to analyse the status of food security. The results of the study indicated that families using irrigated farming in both north and south transects (86.7 % and 85.1 %, respectively) were better off in terms of food security as compared to families relying on rainfed farming (78.7 % and 72.9 %, respectively). Making use of irrigation enables households to increase their income and diversify their food intake. As a result, irrigation should be considered in development goals and initiatives relating to food security through agricultural productivity.

P4-5**Urban sprawl and Food security: A case of the rural-urban interface of Bengaluru**

Udaykumar M.S.^{1*}, Umesh K.B.¹, Gaddi G.M.¹

¹ Department of Agricultural Economics, University of Agricultural Sciences Bangalore, Bengaluru
Karnataka

*Corresponding author: msudaykumar94@gmail.com

Abstract

Today's global urbanisation is broadly a population shift from rural to urban areas, the corresponding decrease in the proportion of people living in rural areas, and the ways in which societies adapt to this change. Urbanisation is not just expansion of urban geographies, but implies overall socio-economic development, of which food habits is one. Farmers who were confined to sustain their own food needs, have transformed to grow crops which the city demands. This process has not only diversified the farm to fill the farmers wallet but also diversified the food plate and the diet they consume. With this backdrop, the current study analysed the impact of urbanisation on food security status, dietary diversity, and calorie intake across rural urban interface of north of Bengaluru. Results indicated that the Household Dietary Diversity Score (HDDS) was higher in the urban area (8.45) compared to transition (7.46) and rural (6.95) areas. This infers that urban households have more variety in their consumption basket due to higher income level and better market accessibility in urban areas. The percentage of food secure households was higher in the urban area (76.3 %) followed by transition (63.8 %) and rural areas (58.8 %). The total energy derived from different food items consumed was highest in the urban area (2491.90 Kcal/capita/day) followed by transition (2416 Kcal/capita/day) and rural areas (2383 Kcal/capita/day). Monthly income of the sample households, their localisation in urban and transitional parts of the gradient, and dummy for land sale are the major determinants of calorie intake across rural-urban interface. The study concludes that both urbanisation and food security are like wheels of the vehicle as envisioned by SDGs 11 and 2, respectively, to carry out the destiny of development of mankind, leaving no one behind in the journey.

K5 – The development of agricultural prices – short-run shocks, long-run trends and implications**Stephan von Cramon-Taubadel**

Department of Agricultural Economics and Rural Development, Georg-August-Universität Göttingen, Göttingen, Niedersachsen, Germany

Abstract

Since the onset of the so-called industrial revolution, agricultural prices have tended to fall relative to the prices of other goods and services. This trend has shaped economic development around the world and generated huge benefits, but also subjected agricultural populations and rural areas to enormous pressures. There are indications that this trend is coming to an end and that a number of price shocks since the turn of the century are harbingers of a new era of increasing global agricultural prices. If so, what are the implications for the co-evolution of agriculture and the environment, for hunger and for the complex interaction between rural and urban in the years to come? In this presentation I will attempt to provide a few insights into these questions from a global perspective but also with reference to experience gained through our joint Indian-German Research Unit.

Special Session**K6- Urbanisation and climate change: Two imperatives for the 21st century****Karen Seto**

Frederick C. Hixon Professor of Geography & Urbanisation Science, Faculty Director, Hixon Center for Urban Ecology, Yale School of the Environment, Yale University, USA

Abstract

The pace and magnitude of urbanisation are unprecedented. Every day, an area equal to about 20,000 soccer fields become converted to urban uses. Every five days, the global urban population increases by about one million. Currently, urban areas contribute to about 67-72% of global emissions. With urban land areas expected to triple in size between 2015 and 2050, massive infrastructure build-up will result in carbon lock-in and the global share of future urban GHG emissions will increase through 2050. In this talk, I will discuss trends in urbanisation and the challenges they present for global sustainability. I will present key findings from the 2022 IPCC report and other new results that document the effects of urbanisation on land, biodiversity, food systems, and regional and global climate.

Session 5: Research networks and future perspectives

K7 - History and future of rural-urban transitions

Andreas Buerkert, Ellen Hoffmann

Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, University of Kassel, Witzenhausen, Hesse, Germany

Abstract

Since permanent early human settlements emerged some 9000 years ago in the Middle East, their hinterlands have been deprived of material resources. The largely uni-directional fluxes in carbon, energy, nutrients, water from “the rural” to “the urban” have enhanced the area- and labour-productivity of increasingly intensified agriculture within and around urban zones. However, they have also led to profound changes in ecosystem services along resource and settlement gradients. Under these conditions water has often changed its function from a vital resource for the survival of plants, animals, and humans to a medium of disposing health threatening contaminants. Similarly, the role of non-renewable land resources shifted from a means of carbon fixation for food and feed production to a permanently sealed building ground. Throughout history the survival of settlements depended on the systems’ ecological buffering capacity and the socio-political capacity of societies to counterbalance the spatially differentiated negative effects of resource accumulation and deprivation. This presentation illustrates some key consequences of rural-urban gradients and the subsequent transformations with examples from India and Morocco. Using the emerging concept of “Sustainable *Rurbanity*” we will attempt to show how resources, society, and regulatory systems interact in shaping new forms of spatial and social-ecological arrangements which offer a mosaic of new livelihood options hard to predict following traditional gradient theories of development. These livelihood options strongly depend on the social and political context, but in an increasingly globalized world also on comparative advantages in productivity, creativity, and the exploitation and construction of system resilience.

S5-1**Trees in Bengaluru: Some illustrations of remote sensing support and spatial analyses in FOR2432**

Christoph Kleinn¹, Divakara B.N.², Tewari V.P.², Nils Nölke^{1*}

¹ Forest Inventory and Remote Sensing, Georg-August-Universität Göttingen, Göttingen University of Göttingen, Niedersachsen, Germany

² Institute of Wood Science and Technology, Bengaluru, Karnataka, India

* Corresponding author: nnoelke@gwdg.de

Abstract

Trees serve a number of environmental and ecological functions in the urban and the rural context. Bangalore is a megacity that has large trees even in the center of the city. The presentation addresses some topics of our research contribution to FOR2432 that had been implemented in collaboration between the University of Göttingen and the Institute of Wood Sciences and Technology in Bangalore. Our research focussed on assessment and analyses of trees within the project's transects and on providing remote sensing imagery and some analysis support. On 60 observation plots of 1ha each all trees (larger than 10cm *dbh*) were measured, mapped in WorldView3 imagery and their crowns delineated both in 2018 and in 2021. A further field campaign will be organized in 2023 so that a unique time series will be available. Our data sets allowed us to make analyses, amongst others, of the tree species diversity, of changes between 2018 and 2021, and on tree cover along the rural-urban gradient. As green spaces together with impervious surfaces contribute to defining "urbanity" viz. "degree of urbanization" we also researched into this tricky but so relevant definition challenge. Here we followed two research lines: (1) the traditional one based on indicator variables, and (2) an expert-opinion-based approach via an online set of imagery that the project members were asked to assess for their "degree of urbanization". As a further support to FOR2432, we developed a web-GIS that accommodated our plot positions and remote sensing data, thought to be a platform for the whole of FOR2432 to illustrate the spatial positions of the field work of the individual projects and to foster linking projects for synergies.

S5-2**Rural neglect, peri-urbanisation, and the development of *rurbanity* in Casablanca, Morocco**

Hassan Rhinane

University Hassan II of Casablanca, Faculty of Sciences Ain Chock, Casablanca, Morocco

Abstract

Given its political stability as the world's oldest monarchy Morocco has been remarkably successful in planning urbanisation whereby its focus was on designing and implementing urban settlement structures and peri-urban areas. The country was less successful in addressing the consequences of rural-urban transformation on rural oasis settlements that for hundreds of years shaped its culture and provided sustainable agro-pastoral livelihoods for large populations of different ethnic groups. Lacking job and educational opportunities in remote areas have led to major out-migration, widespread land abandonment, and losses of ecosystem services in the countryside. This presentation will address the dichotomy between rural neglect and subsequent migration, well planned (peri-) urbanization, and the new role of *rurbanity*. The latter phenomenon is understood as the emergence of new social structures that take advantage of urban opportunities for educated young while rural migrants struggle for survival with poorly paid jobs. Connections of migrants to rural settings remain sketchy and largely depend on whether rural environments can be used for recreational activities or tourism. While agricultural land use in (peri-)urban areas and their hinterlands takes advantage of decent infrastructure in irrigation, roads, connections to urban markets, and social services, rural production opportunities decline. The described dichotomy in spatial developments often causes frustrated- uneducated but also unemployed educated populations to continue their out-migration to Europe and beyond.

S5-3**Crossing conceptual boundaries for sustainable livelihoods in Accra, Ghana**

Martin Oteng-Ababio

Department of Geography and Resource Development, University of Ghana, Legon, Accra, Ghana.

Abstract

This presentation explores the degree of organisation, complexities, and embedded potentials in informal worlds of work in and around Agbogbloshie (Accra), a site that has achieved international and national notoriety for its ostensible environmental and social challenges. The analysis empirically shows how informality remains a persistent, substantial, and defining feature of Ghana's economy in fostering growth and creating jobs, albeit its overall role in the national development discourse is largely ignored or seldom considered. Drawing on participant observation and qualitative field-based survey data, the study unfolds the multidimensional ways migrant women from northern Ghana adopt to innovate, network, and "graduate" from e-waste-related activities to engage in long-distance trade, which catalyses spin-off activities that manifest differently between the south and the north of the country. It also sheds light on how these women, with little prospect of formal employment, negotiate contemporary economic shifts and create an occupational continuum that defies strict compartmentalisation. The study adds to the expanding corpus of research on informalisation as a growing, noteworthy, and integral feature of sub-Saharan Africa's economy.

S5-4**Urban-rural interactions in desert lands: The camel chain in Zagora and Guelmim, Morocco**

Taha Lahrech

Institut Agronomique et Vétérinaire Hassan II, Department of Human Sciences, Rabat, Morocco

Abstract

Desert lands are particular in terms of urban-rural interfaces, landscapes, and layouts. No observable human landscaping is spotted in rural desert areas, and the urban-rural geographical gradient is almost inexistent. As the rural space got reduced to transhumance paths and dunes became touristic spots, breeders and farmers inhabit urban peripheries. Breeding activities, dairy or meat productions, and touristic services are spread out between urban and rural spaces in a way considering output features, physical capabilities, and flows of water and feed resources. These have structural implications when it comes to design agricultural development policies in desert lands. In Morocco, alimentary traditions, thoughts, and preferences have led to consider camel milk and meat as must-have products for autochthones, strengthening the economic symbiosis and material flows between desert urbanity and its surrounding rural areas. The camel value chain is presented as an example to highlight the changing urban-rural interactions in desert lands.

Panel discussion: Reflecting narratives of global trajectories

The five sessions of this conference have presented and discussed many examples and aspects of rural-urban transformation in the metropolitan region of Bengaluru, and gave a few glimpses on other regions of the world, or from an overarching global perspective. In the panel discussion we aim to reflect and position them in the broader scientific discourse. Which are the dominating narratives and trajectories for our future?

Urbanisation – Renown scientists claim that we already living in an “urban age”^[1], or on an “urban planet”^[2]. Is that a problem or a solution for sustainable development?

Agriculture – How can we feed the growing human population? On a “cultivated planet”^[3] agriculture competes with growing cities on the one hand, and encroaches on natural habitats on the other. Can “nature” be preserved by land sparing or land sharing?

Conservation – A policy agreement at COP15 in 2022 calls for protecting 30% of the Earth’s surface by 2030 to preserve natural habitats. Areas that are important for biodiversity, however, occur also outside of protected areas, and even within presumed intact wilderness present biomes and ecosystems have co-evolved with human societies as “anthromes”^[4]. What makes land use and land use changes sustainable?

What are the driving forces behind agricultural intensification, economic growth, or global warming, and how do they play out at different scales (field/household – regional – national – global scale)? What is needed to unravel these complex interrelations? – New concepts? More empirical data? More collaboration across scientific disciplines and socio-cultural backgrounds?

Panelists:

Prof. Dr. Karen Seto

Prof. Dr. Andreas Buerkert

Dr. Soubadra Devy

Prof. Dr. Martin Oteng-Ababio

Prof. Dr. Taha Lahrech

Dr. Nitya Mittal

Moderation:

Dr. Ellen Hoffmann

References

^[1] Brenner, N. and Christian Schmid, C. 2014. The ‘Urban Age’ in Question. *International Journal of Urban and Regional Research* 38(3), 731-755.

^[2] Seto, K.C. and Reba, M. 2018. *City Unseen: New Visions of an Urban Planet*. Yale University Press, New Haven, CT, USA.

^[3] Foley, J.A., Ramankutty, N., Brauman, K.A. et al. 2011. Solutions for a cultivated planet. *Nature* 478, 337-342

^[4] People have shaped most of terrestrial nature for at least 12,000 years. Ellis, E.C., Gauthier, N., Klein Goldewijk, K., et al. (2021) *PNAS* 118(17), e2023483118

GKVK Campus - Location map

