Reducing Global Methane Emissions:

Report from a University-Wide Research/Outreach Initiative

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New Horizons in Methane-Emissions Abatement

Side Event Room 5, Blue Zone, COP29, Baku, Azerbaijan
November 12, 2024

Why Focus on Reducing Global Methane Emissions?

- **Methane has received much less attention than carbon dioxide (CO_2) as a driver of climate change**
  - Absolute quantities of anthropogenic methane (CH_4) emissions are *much less* than those of CO_2
  - And the half-life of CO_2 in the atmosphere exceeds 100 years, but CH_4 atmospheric lifetime is only about 12 years
- **However, methane has *very high global warming potential per unit*, compared with CO_2**
  - Over 100 years, each methane unit is *28 times* as effective in radiative forcing
  - And over 20 years, its *84 times* as effective!
  - Historically, methane is responsible for about *30%* of global warming since the industrial revolution
- **So, methane-emissions abatement can significantly reduce GHG concentrations, climate change, and damages … particularly in the *short term*!**
- **This can give the world time to:**
  - *"bend the curve"* on CO_2 emissions
  - conduct *research* on carbon mitigation and removal
  - *implement* longer-term strategies to mitigate and adapt to climate change

Harvard Initiative on Reducing Global Methane Emissions

- **In 2023, we launched a Harvard-wide "Initiative on Reducing Global Methane Emissions"**
  - Sponsored by Harvard's Salata Institute on Climate and Sustainability
- **Goal is to achieve *meaningful and sustained* progress in methane emissions reductions** …
  - … through *research and effective engagement* with key stakeholders …
  - … to deliver information facilitating *design & implementation* of emission-reduction *policies & programs*
- **This presentation:**
  - Provide an overview of the Initiative (which I'm directing)
  - Very briefly describe a few of the research projects of the Initiative

Harvard Initiative on Reducing Global Methane Emissions (continued)

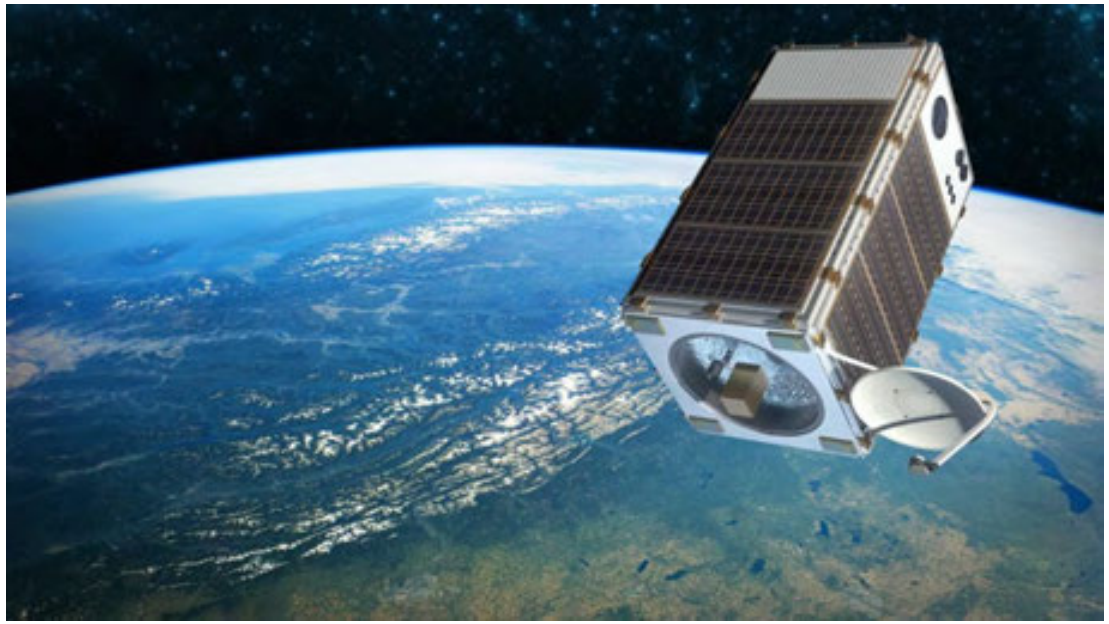
- **Brings together two dozen researchers, including Harvard faculty from across university plus external collaborators**
  - *Seven departments* in FAS – from Sciences, Social Sciences, and Humanities
  - *Five professional schools*: Business, Engineering, Government, Law, and Public Health
  - *Disciplines*: physics, chemistry, biology, engineering, economics, political science, law, business, and history
  - By collaborating across research teams, *the whole can be greater than sum of its parts*: frequent interaction among researchers; building on synergies; advancing cross-disciplinary understanding
- **We're working to translate research into *useful* materials**
  - Preparing written *briefs* and *videos; and m*eetings with *government, NGO, and business leaders*
- **Overall theme: seeking to *translate* science into *action***
  - Engaging in *two-way communication* with government, business, NGOs, and international organizations
  - This includes governments and stakeholders at the international, regional, national, and sub-national levels
- **In first year (of three-year initiative), we launched *seven projects* …**

Seven First-Year Projects of the Harvard Methane Initiative

- *Satellite Observations of Atmospheric Methane for U.S. Reporting Needs*
- Methane & Markets: Firm Incentives to Emit
- Arctic Methane Emissions and Climate Mitigation
- *Estimating Economic Costs of Reducing Methane Emissions*
- Using Remote Sensing Data to Inform Micro-Histories of Release Sites
- Methane and International Trade
- International Cooperation to Reduce Methane Emissions

Satellite Observations of Atmospheric Methane for U.S. Reporting Needs

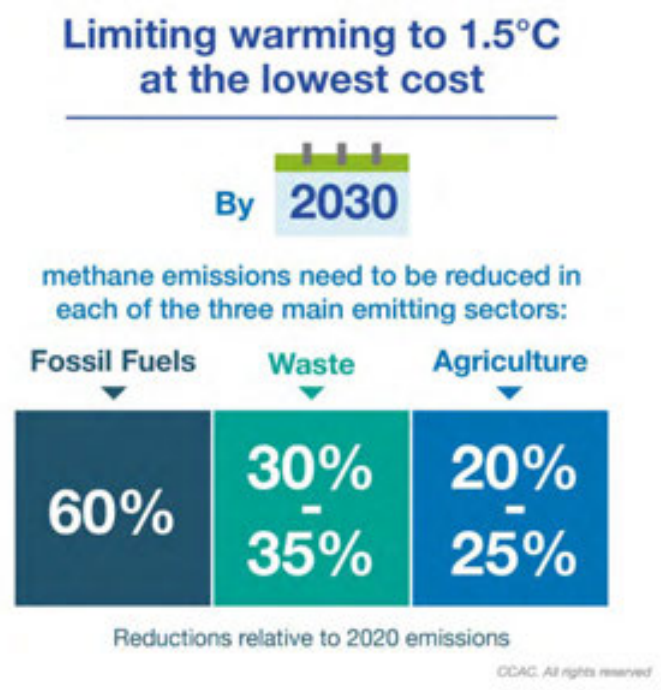
- **Goal:**
  - Increase *value of satellite observations* of atmospheric methane for reporting & regulation of methane emissions in the United States
- **Specifically:**
  - Improve *reporting* of methane emissions from landfills under U.S. EPA's Greenhouse Gas Reporting Program
  - Develop a *near-real-time satellite-based monitoring system* for verification of emission reductions and quantification of methane intensities (using Tropospheric Monitoring Instrument – TROPOMI – and MethaneSAT)



- **Leaders:**
  - *Daniel Jacob* – Department of Earth and Planetary Sciences, FAS
  - *Carrie Jenks* – Harvard Law School
- **Activity & Progress:**
  - Convened group of scientists & advocates on Jan. 18, 2024, to address landfills (see above); identify and implement steps to support revision of landfill performance standards under Clean Air Act Section 111
  - Development of real-time monitoring

Estimating Economic Costs of Reducing Methane Emissions

- **Goal:**
  - Apply *empirical methods* to improve cost estimates, and identify *policy instruments* to reduce abatement costs
- **Specifically:**
  - Review literature on three types of cost estimates: *engineering cost* estimates; *econometrically estimated* costs; and costs *revealed* through public policies
- **Leaders:**
  - *Joseph Aldy* – Harvard Kennedy School
  - *Forest Reinhardt* – Harvard Business School
  - *Robert Stavins* – Harvard Kennedy School



- **Activity & Progress:**
  - Release working paper and policy brief in Fall of 2024 that ***surveys and synthesizes*** abatement cost estimates in O&G sector
  - Second Year: original econometric estimates of abatement costs, w/*empirical data* on O&G fugitive methane *emissions*, technologies, oil & gas production and nodal *prices*, etc.

Fourteen Additional Projects in Year 2 of the Initiative

The Harvard Methane Initiative, in its second year (began July 2024):

- *Extending research beyond the oil and gas sector to address sources in agriculture and landfills*
- *Extending research outside of the USA*

New Research/Outreach Projects:

- **Agriculture:**
  - Intelligent Nature-Inspired Olfactory Sensors Engineered to Sniff (iNOSES) for Real-Time Methane Monitoring
  - Policy for and Regulation of Agricultural Methane Emissions in the United States
  - Methane Abatement in Livestock: Making Markets for Feed Additives in the Global North and Global South
  - *Methane Mitigation from Dry Cultivation of Rice in China*
- **Waste/Landfills**
  - Improved GHGRP Reporting and Reduction of Emissions from US Landfills

Fourteen Additional Projects in Year 2 (continued)

- **Additional Projects Addressing Emissions from the Oil and Gas Sector**
  - The Market and Climate Implications of U.S. LNG Exports
  - Econometric Estimation of Methane Abatement Costs
  - High-frequency Variability of Emissions from U.S. Oil & Gas Production Regions
  - Policy Options for Reducing Methane Emissions
  - Global Climate Impacts of U.S. LNG Exports
  - Establishing the Representativeness of Remote-Sensing Observations of Methane Point Sources
  - Coordinating with Industry on Emissions Monitoring
  - Regulatory Obstacles & Opportunities for Well-Capping in Pennsylvania
- **Cutting Across Sources and Sectors:**
  - *Integrated Methane Inversion Training for Stakeholders*

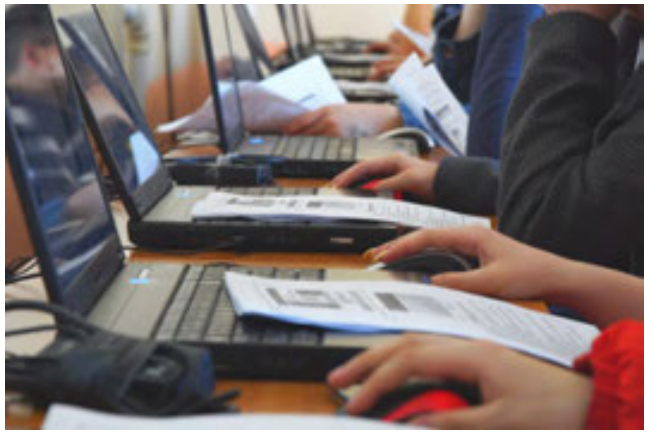
Methane Mitigation from Dry Cultivation of Rice in China

- **Goal:**
  - Using econometric methods, estimate the impact on reduction of methane emissions in China by substituting dry cultivation of rice for paddy rice production
- **Specifically:**
  - Using data from Landsat, GOSAT, and TROPOMI, examine the degree to which dry cultivation reduces methane emissions
  - Examine side effects, including on yield, agricultural revenue, and water use
  - What is the return to government's subsidy for dry cultivation, including as a climate mitigation strategy in terms of $/avoided CO_2e emission?

- **Leaders:**
  - *Xinming Du*, Salata Institute for Climate and Sustainability, on sabbatical leave, National University of Singapore
  - *Charles Taylor*, Harvard Kennedy School (advisory role)
- **Activity & Progress:**
  - Research is underway; paper to be delivered in late summer 2025

Integrated Methane Inversion Training for Stakeholders

- **Goal:**
  - Execute (remote) workshops to enable users to infer methane emissions from satellite data
- **Specifically:**
  - User-friendly, open-code Integrated Methane Inversion (IMI) tool on Amazon Web Services (AWS) will enable stakeholders with no prior expertise to conduct inversions, visualization, and processing of satellite data
  - Half-day workshops to be offered separately for Americas, Europe/Africa, and Asia; Each workshop to include: (1) overview of IMI; (2) tutorial on using IMI; (3) hands-on application by all participants to a common region; and (4) hands-on application by each participant to their region of interest



- **Leaders:**
  - *Daniel Jacob* – Department of Earth and Planetary Sciences
  - *Daniel Varon* – Department of Earth and Planetary Sciences
- **Activity & Progress**
  - In preparation; to begin in November of 2024

Other Participating Faculty and External Collaborators

- **Other Participating Faculty**
  - *Jody Freeman* – Harvard Law School
  - *Meghan O'Sullivan* – Harvard Kennedy School
  - *Michael Toffel* – Harvard Business School
  - *Mark Brownstein* – Environmental Defense Fund
  - *Nathaniel Hendren* – Department of Economics, MIT

- **Collaborating Institutions (partial list)**
  - Clean Air Task Force
  - Climate and Clean Air Coalition
  - Environmental Defense Fund
  - Office of the U.S. Special Presidential Envoy for Climate, U.S. Department of State
  - Oil & Gas Climate Initiative
  - Resources for the Future
  - U.N Environment Programme
  - World Bank Group

The Path Ahead

- **This review is *incomplete* – we are only 14 months into a 36-month initiative**
  - We anticipate that *more Harvard faculty* members and students will participate, …
  - … as well as *more* external collaborators and collaborating institutions
- **Looking ahead to *second and third year* of initiative:**
  - Themes:
    - *Move beyond* intense focus on Oil & Gas sector: *Landfills*, *Agriculture* (Livestock & Rice Paddies), *Coalbed Methane*
    - More attention to emissions and policy *in other countries*
  - Some projects will continue (with new activities)
  - More projects will be added throughout second and third years

Thank You!

For More Information

Harvard Project on Climate Agreements
www.belfercenter.org/climate

Harvard Environmental Economics Program
www.hks.harvard.edu/m-rcbg/heep

Website
www.stavins.com

Blog
http://www.robertstavinsblog.org/

Twitter
@robertstavins

Salata Institute Initiative on Reducing Global Methane Emissions
https://salatainstitute.harvard.edu/projects/methane/

METHANE REDUCTION

The Climate Emergency Brake

Sarah Smith

Global Methane Hub

The Global Methane Hub

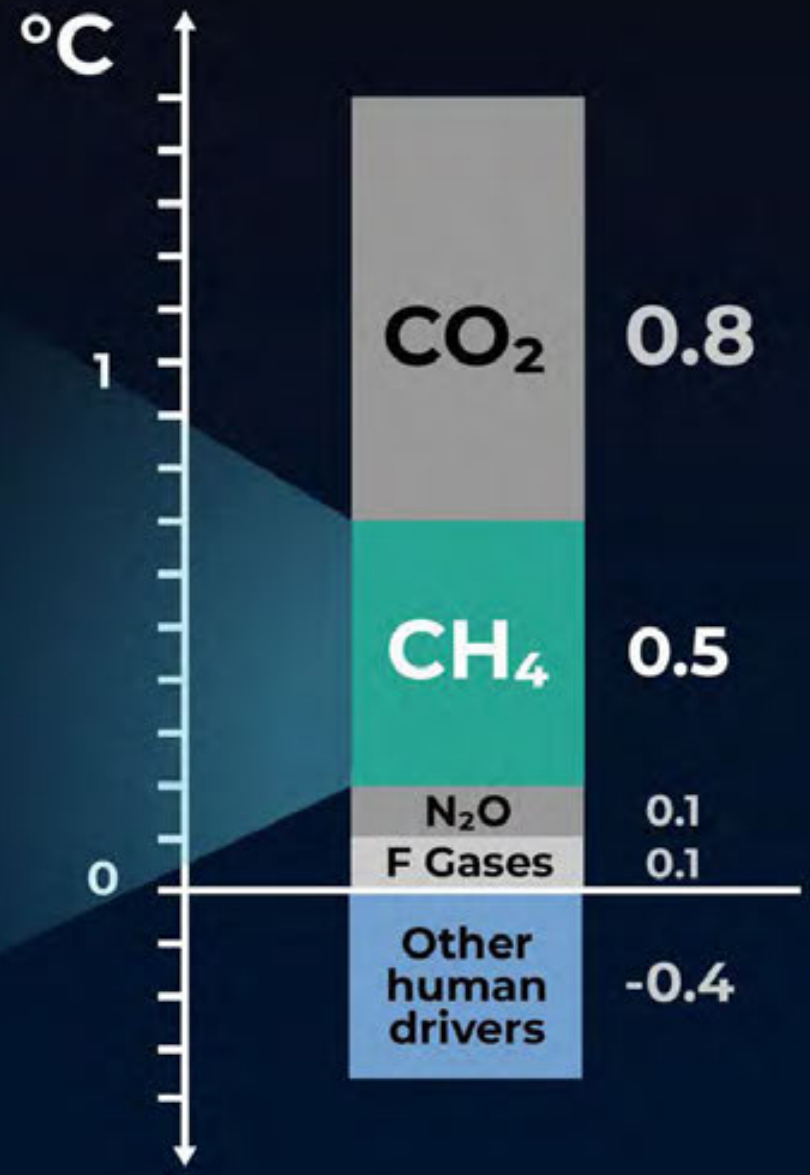
- **Philanthropic effort** to align funding on **methane mitigation** in the **energy, agriculture, and waste sectors**.
- Supporting **Global Methane Pledge** signatories and potential signatories in meeting the pledge and **going beyond**.
- Drive **coordination and collaboration** on methane advocacy while funding **ideas with the highest impact**.

Cutting methane emissions is the fastest, most effective way to reduce the rate of global warming and contribute to limiting temperature rise to 1.5°C

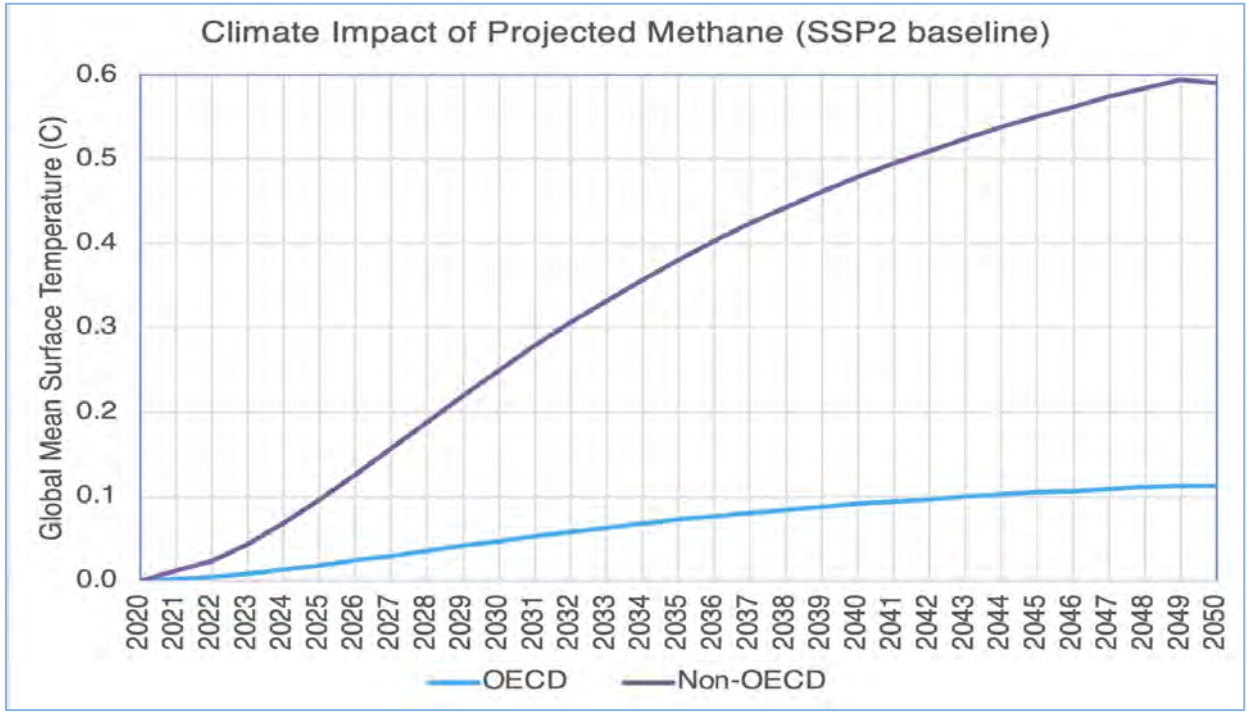
Global Methane Hub

CH_4 has contributed to 45% of recent net warming

IPCC AR6 report.



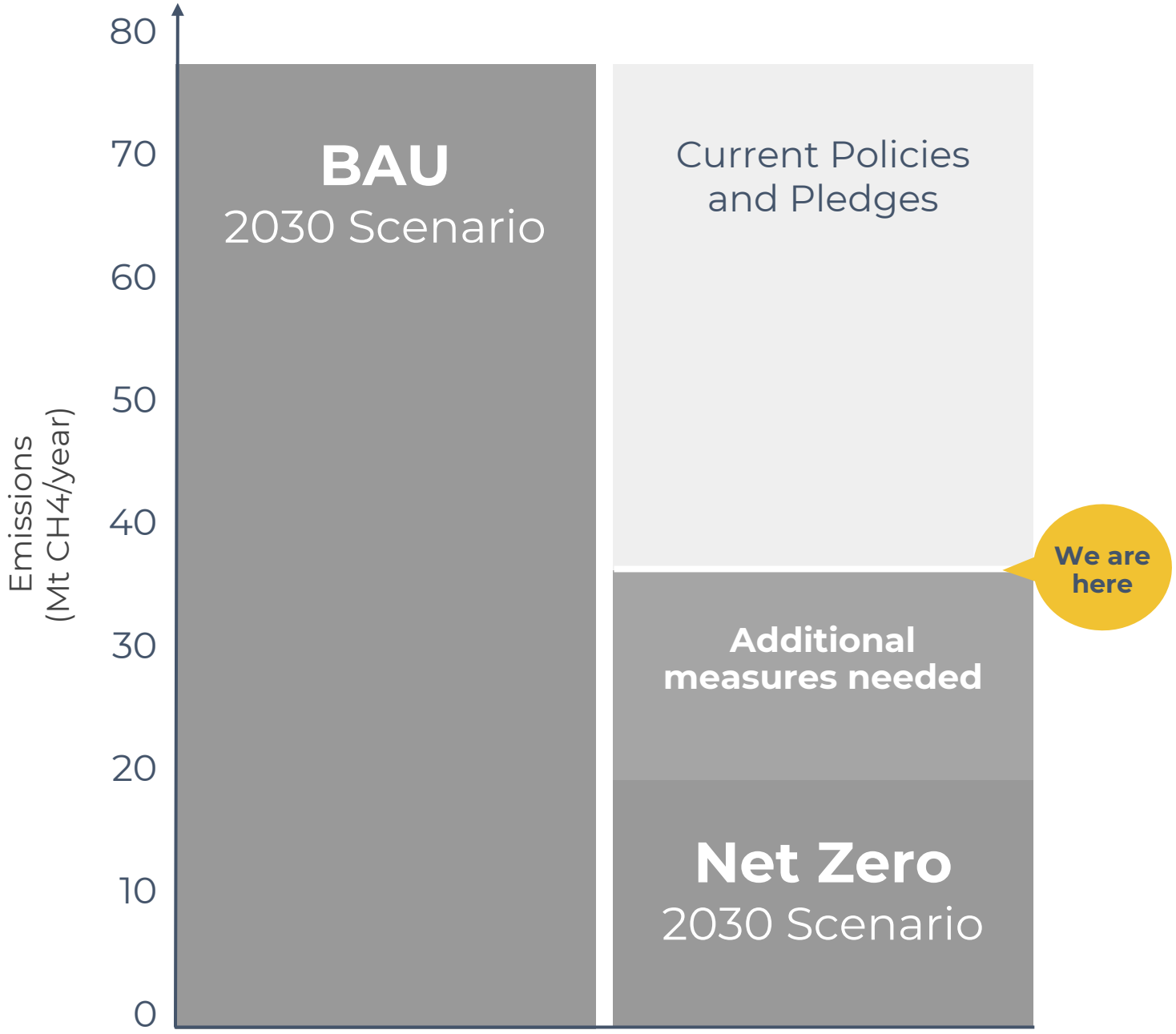
MAXIMIZING IMPACT WHERE IT COUNTS



Shindell et al. 2024. 83% of warming from methane will come from non-OECD countries.

Policies, plans and regulation

ENERGY SECTOR PROGRESS

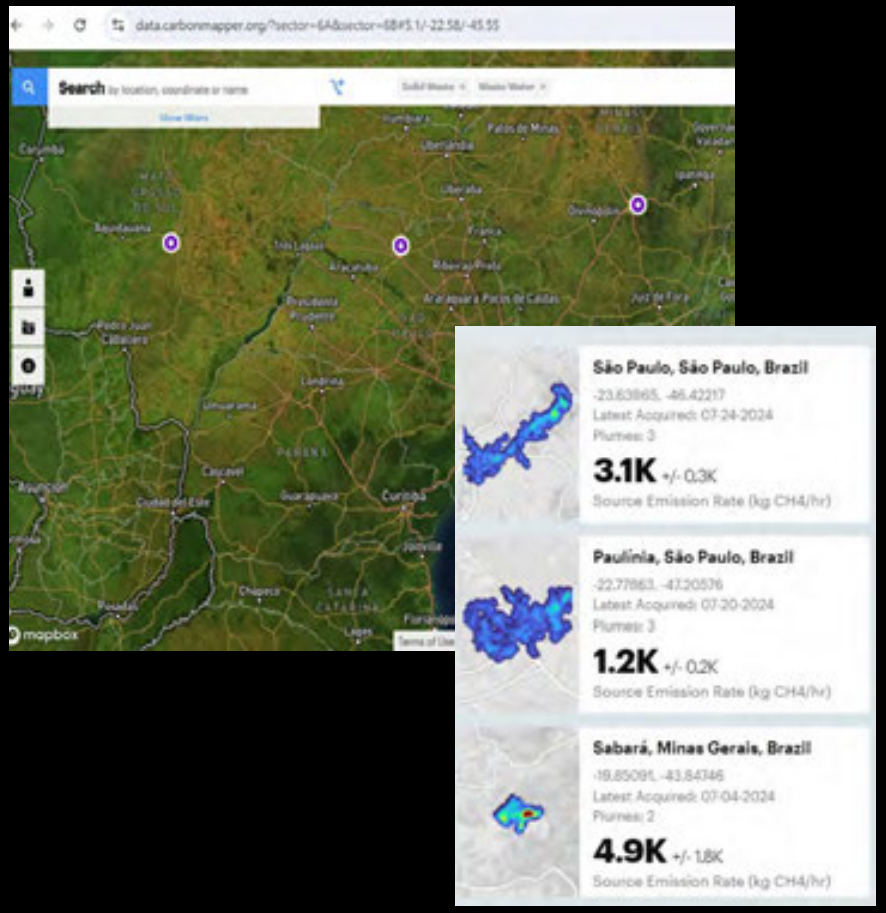


Source: IEA

Two satellites launched in 2024 to help track methane emissions.

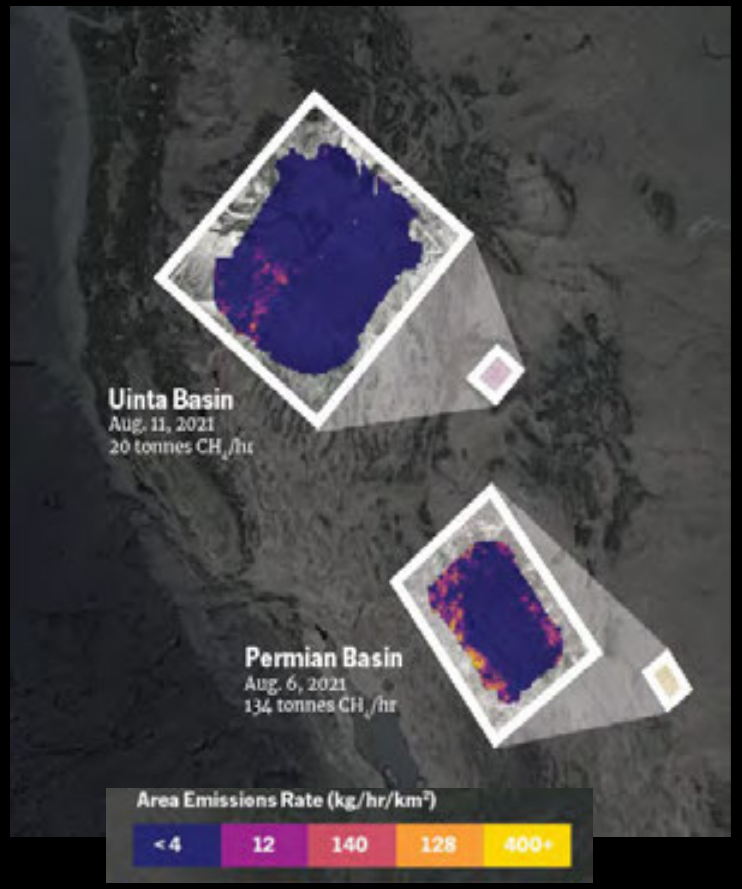
Carbon Mapper

Facility-Level Plume Identification



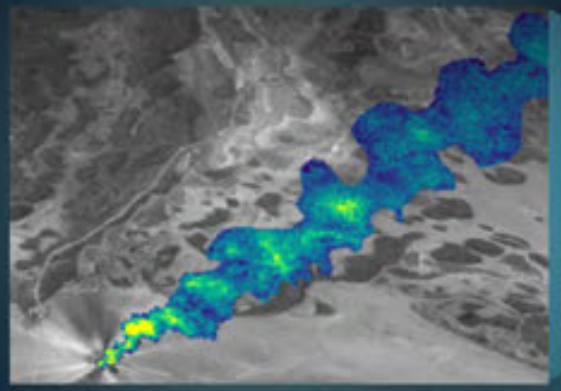
MethaneSAT

Regional-Level Emissions Quantification



Data, measurement and accountability

Scientists say they've detected a huge methane leak in Kazakhstan



Bloomberg

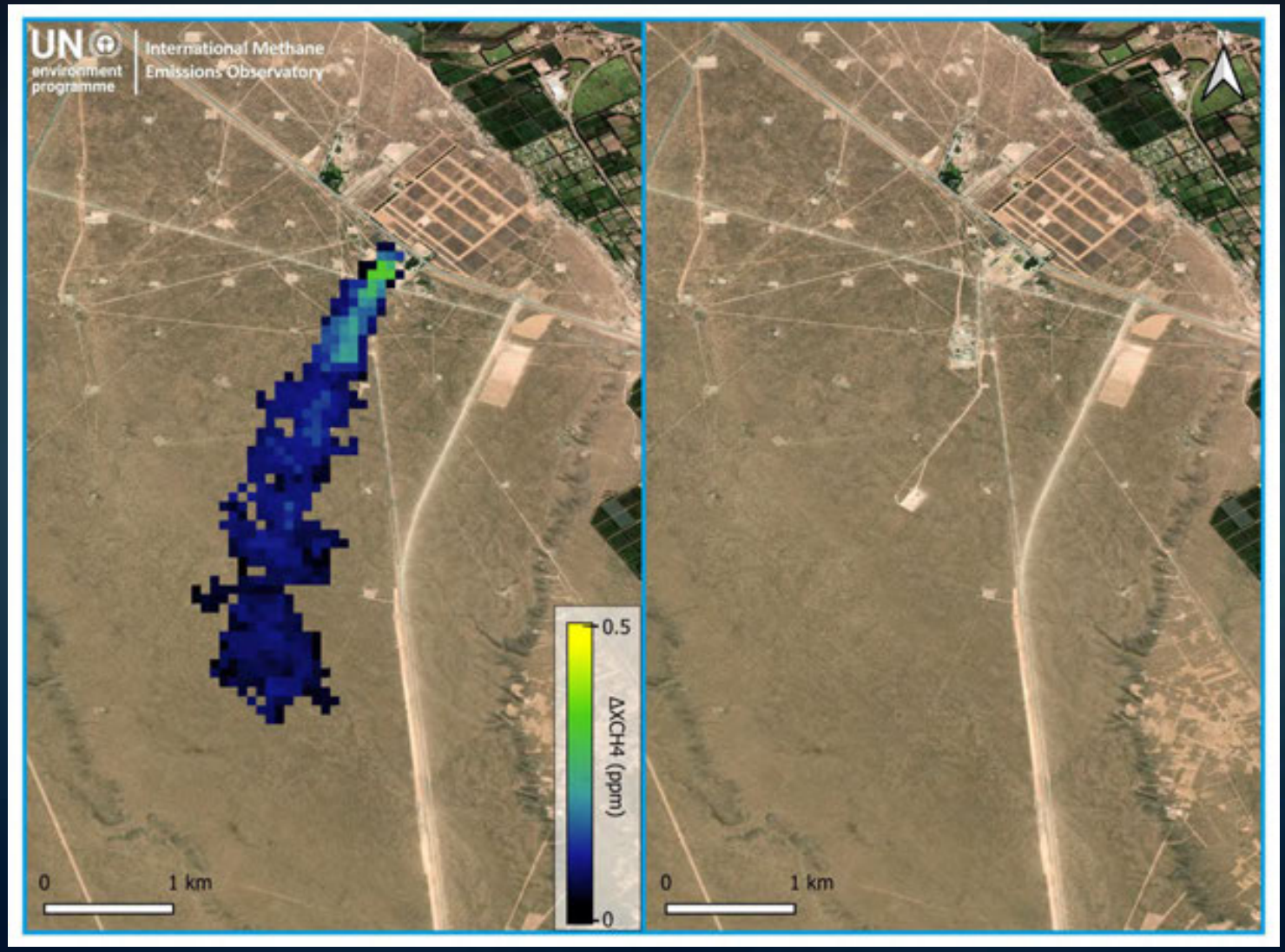
Turkmenistan in Talks With US to Tackle Giant Methane Leaks

Bloomberg

Big LNG buyers and producers tighten methane monitoring

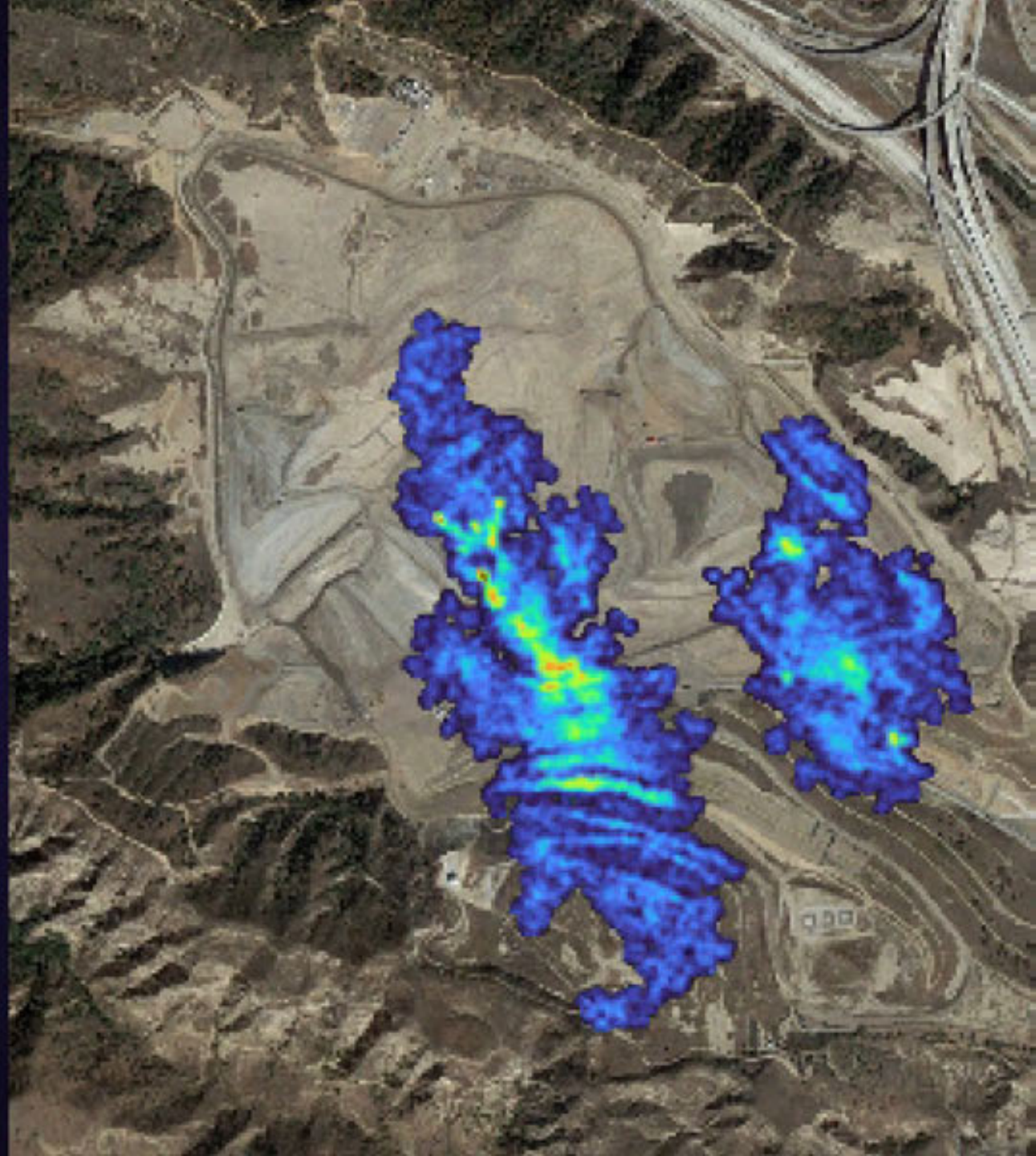
Financial Times

Methane Alert and Response System (MARS)



The Sunshine Canyon Landfill

(March 2017)



The Sunshine Canyon Landfill

(March 2017)

Data, measurement and accountability

- Heat Map & Emissions Data
- Decision Support Tool
- Citizen Waste Champions Community
- End-to-End Waste Management Strategies Playbook
- South-to-South Convenings & Information Sharing

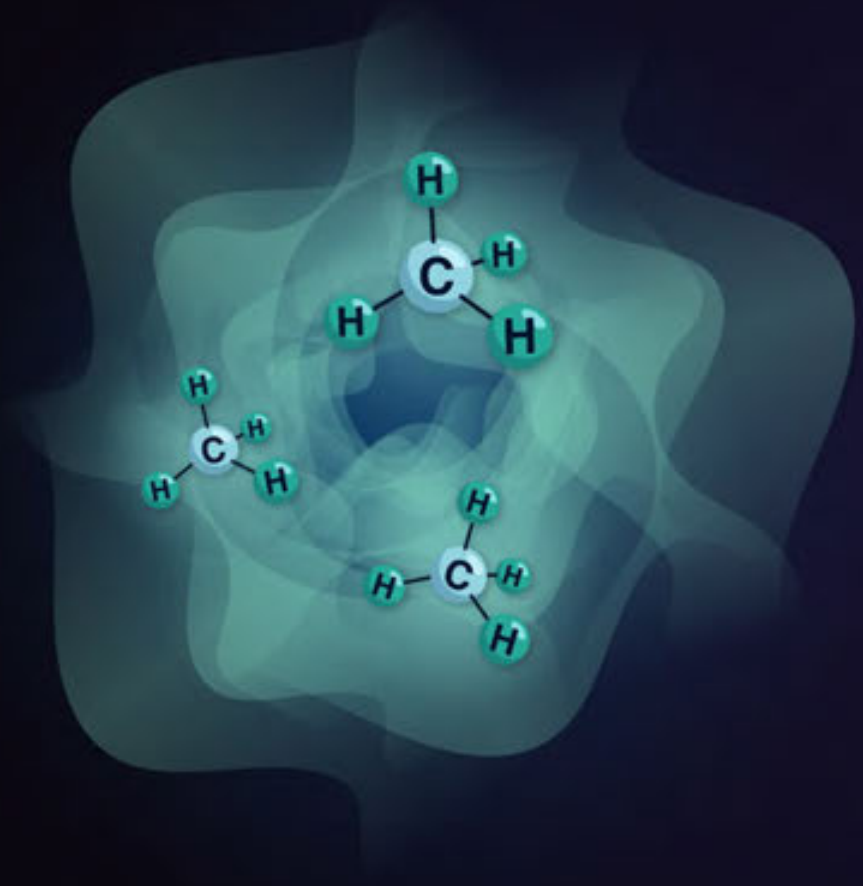
Waste MAP

(Methane Assessment Platform)

Global Methane Hub · RMI · CATF Clean Air Task Force · SRON Netherlands Institute for Space Research · Carbon Mapper · Google

SHIFTING FINANCE
TOWARD METHANE

GMH Deployed **$6.5M** in funding to establish project preparation facilities that helped design initiatives and unlocked **$850M** in methane mitigation finance.



Enteric Fermentation R+D Accelerator


Pull the emergency brake on climate change
Global Methane Hub

THANK YOU

Global Methane Hub

IRRI International Rice Research Institute

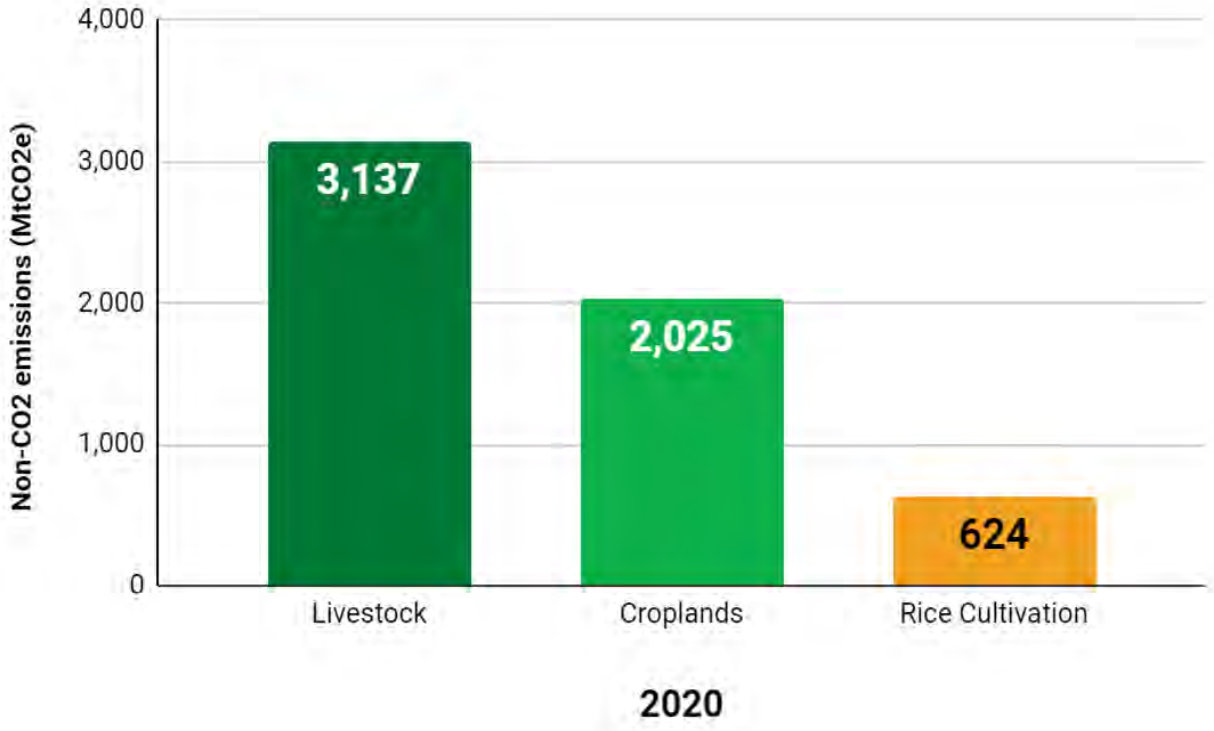
IRRI is a member of the CGIAR

Greenhouse Gas Mitigation in Rice: Towards a comprehensive solution

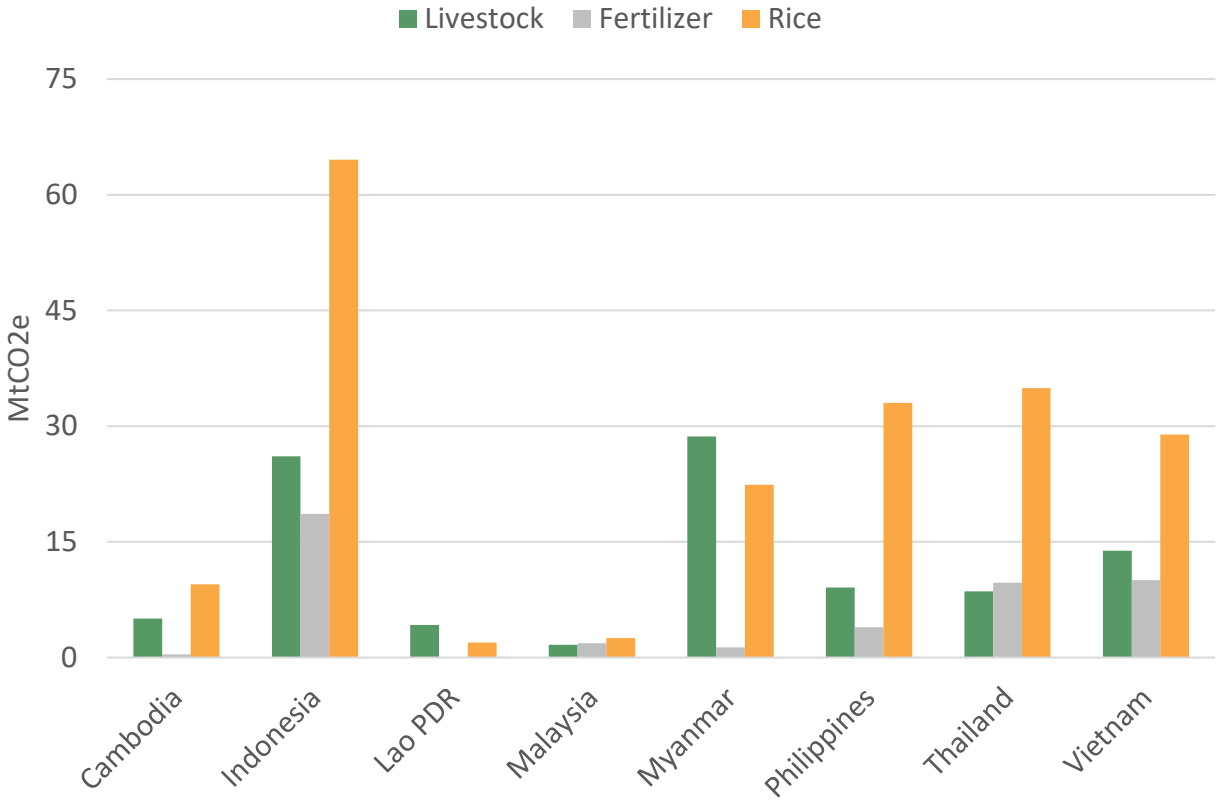
Bjoern Ole Sander, International Rice Research Institute
Senior Scientist and Country Representative to Thailand

Agricultural Emissions

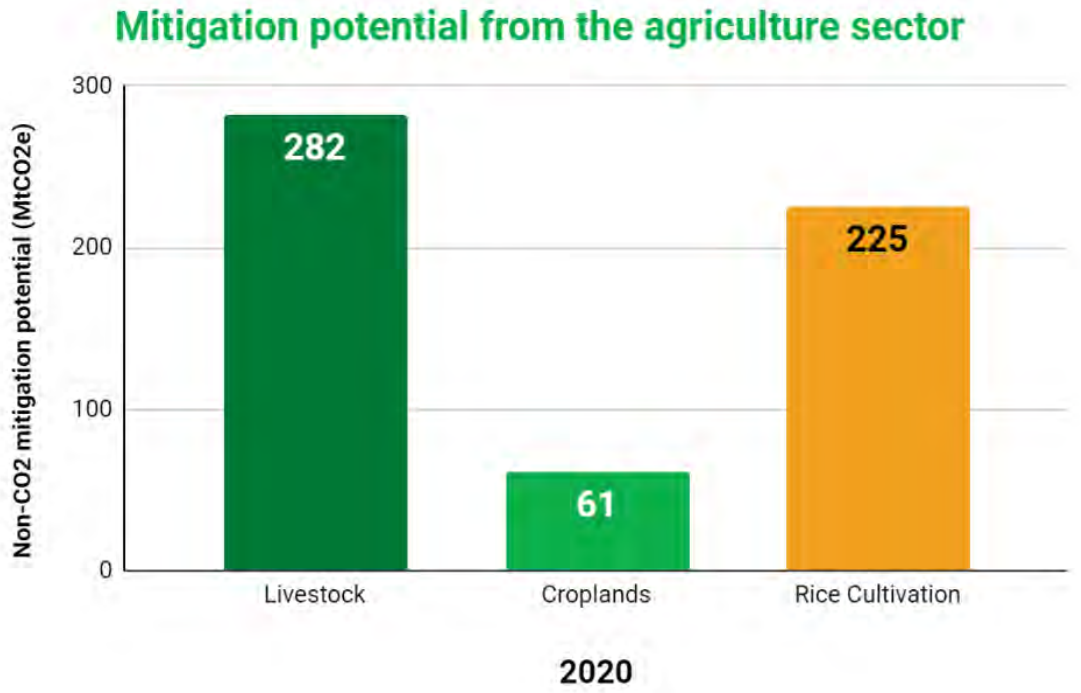
Agricultural emissions globally

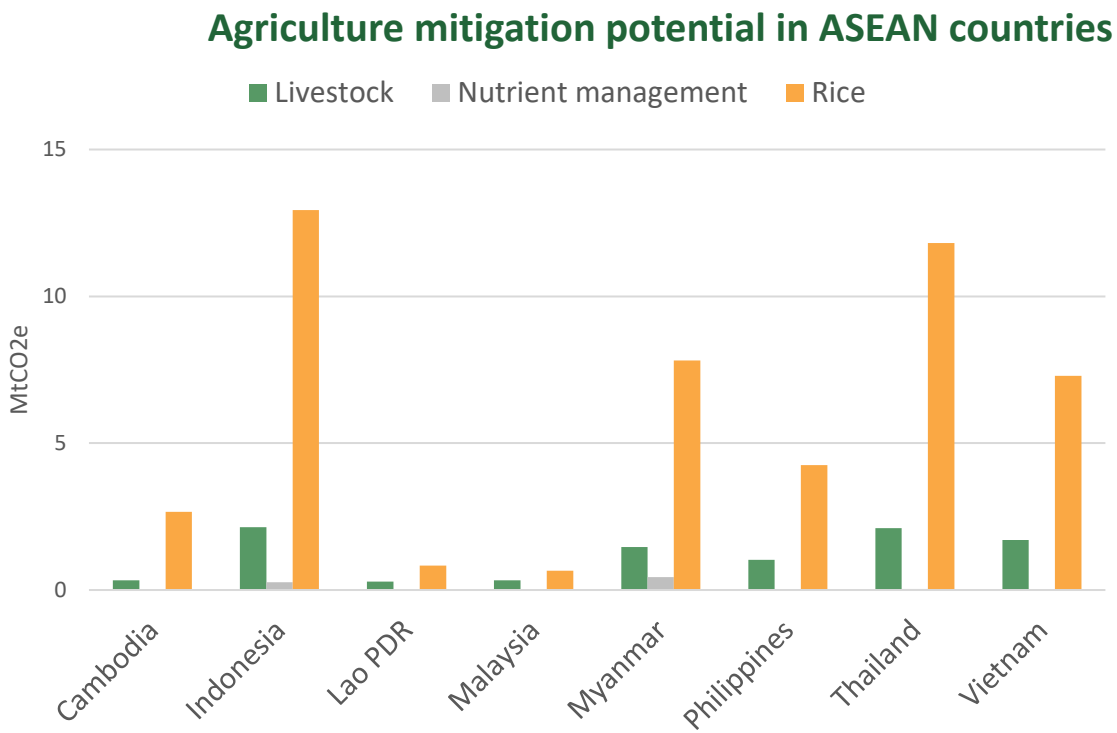


Agricultural emissions in ASEAN countries



An overlooked opportunity

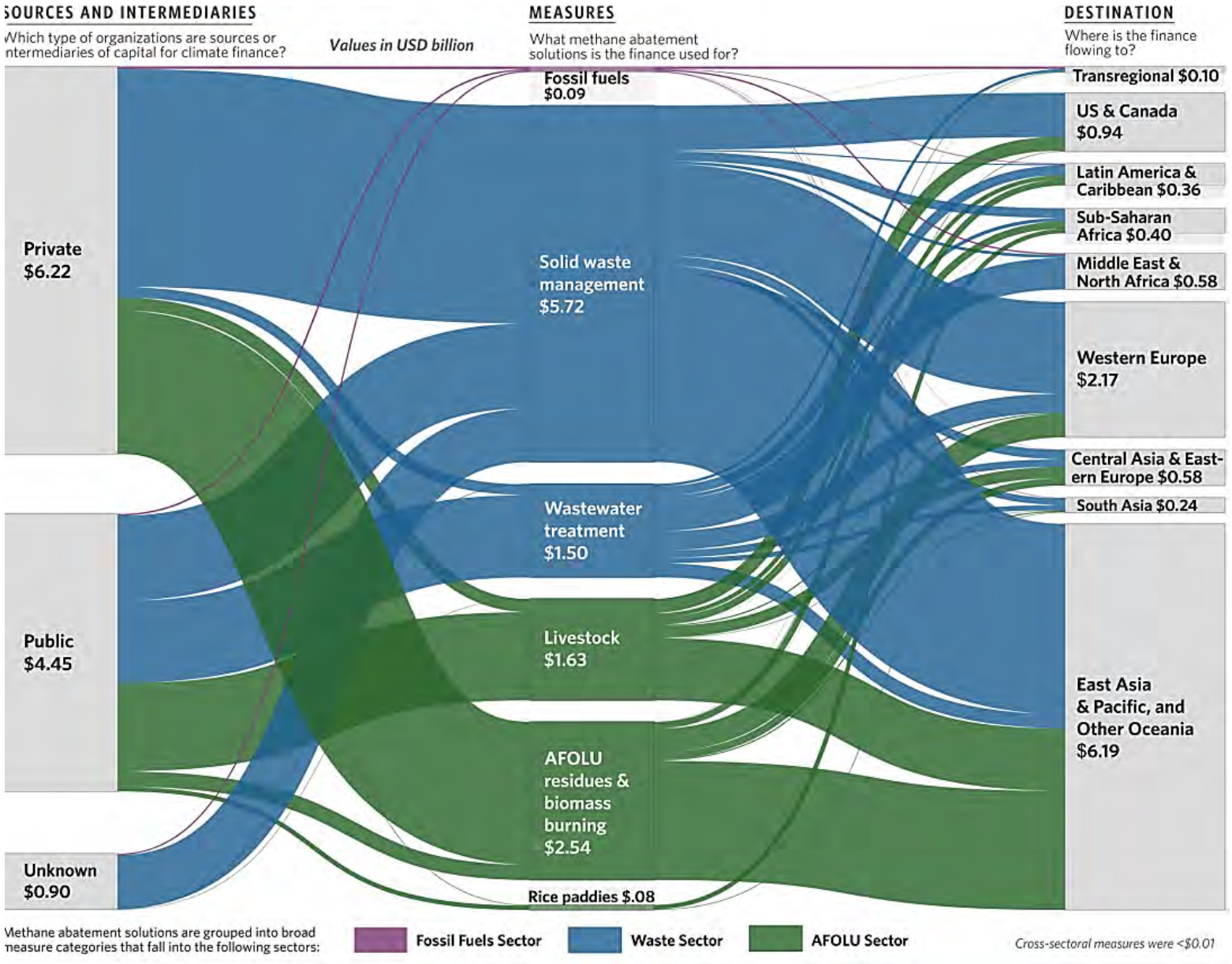




- **The relative mitigation potential for rice (36%) is much higher than that of livestock (9%), and croplands (3%) (Roe et al., 2021; EPA, 2021)**
- **This presents immense opportunities for channelling climate funding to rural communities and smallholder rice farmers**

- **In ASEAN countries, the total mitigation potential for rice (48MtCO2e annually) is much higher than that of livestock (9.4 MtCO2e) and croplands (0.8 MtCO2e) (Roe et al., 2021; EPA, 2021).**
- **Existing rice sector methodologies for voluntary carbon markets**

Global Targeted Methane Abatement Finance Flows in 2019/2020



- **Investments for methane reduction are geared towards waste management and wastewater treatment, followed by livestock and residue burning**
- **Investments in GHG abatement in rice is very low compared to its mitigation potential**

Climate Policy Initiative, 2022, The Landscape of Methane Abatement Finance

Rice Cultivation Cycle

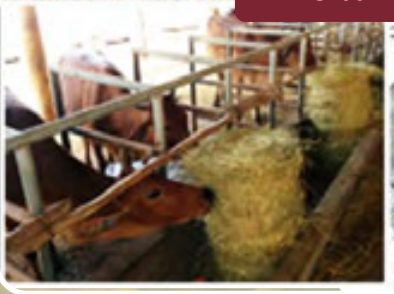
Economic mitigation potential: 36% (Roe et al., 2021)

- Land preparation
- Seeding
- Fertilization
- Growing
- Harvest
- Post-harvest

Compost and biochar for fertilization, mushroom production, feed collection, etc.

Rice straw circular economy approach

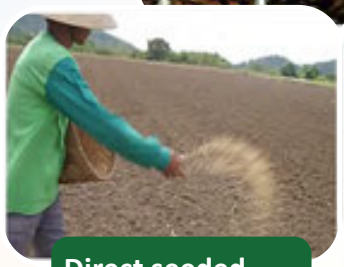
No burning



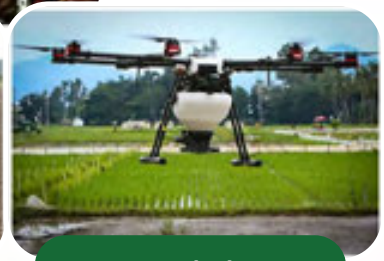
Laser Land Leveling for even surface irrigation

Residue incorporation or removal

Rice variations for optimized crop growth rotations



Direct seeded tice (manual)



Direct seeded rice (mechanized, drone)

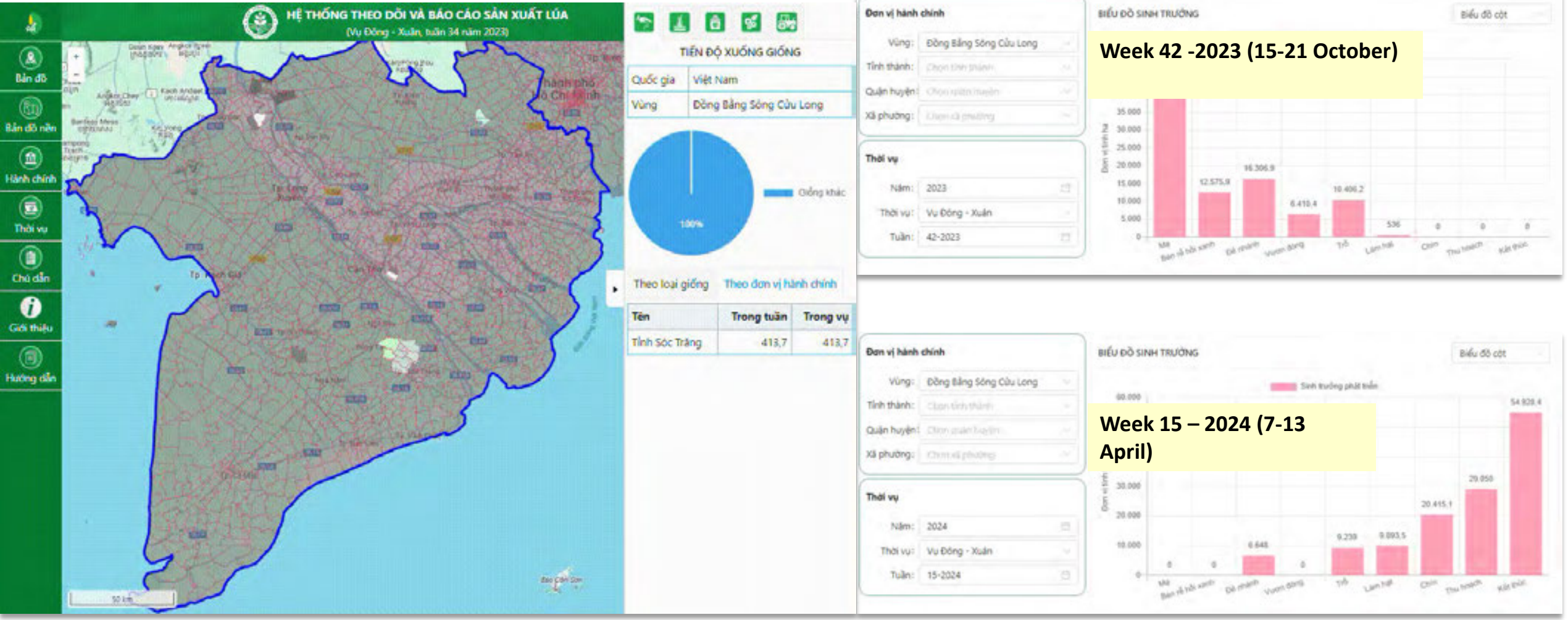
Direct seeded tice + deep fertilization (mechanized, large-scale)

Site-specific nutrient management

Timed harvesting at approx. 90% ripeness

Alternate Wetting & Drying

Digitized Activity data Collection System -RiceMoRe



agresearch
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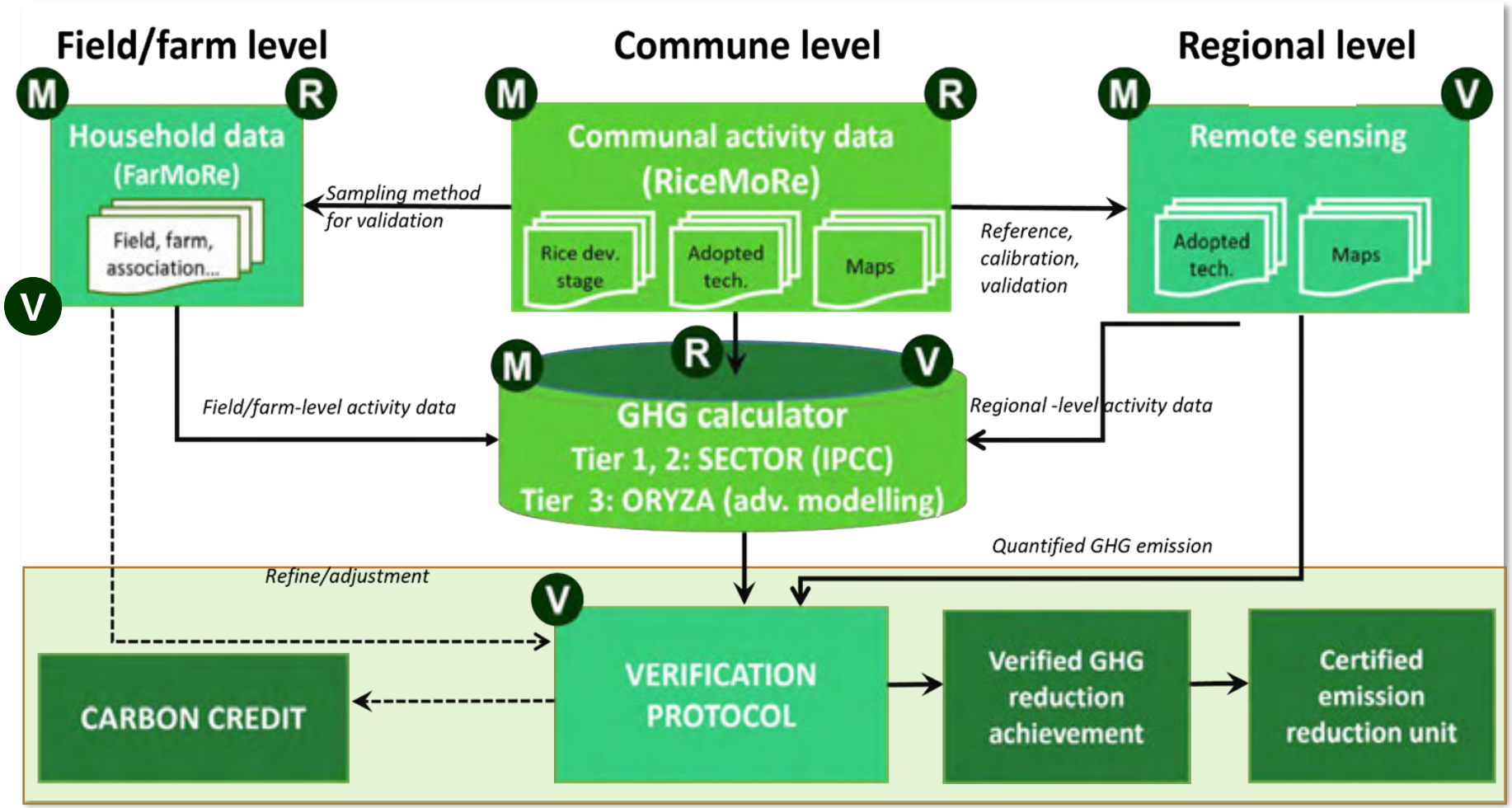
NEW ZEALAND
FOREIGN AFFAIRS & TRADE
Manatū Aorere

IRRI

Proposed MRV framework - Tier 3 reporting

RICE-GEM (RIce Computation Engine for Greenhouse gas Emissions)



- Rice MRV adaptable to carbon markets, NDC tracking and/or national GHG inventories
- Satellite-/remote sensing-enabled
- Simple IPCC-based calculator for advanced GHG modelling (as in Tier 3)

Global Methane Hub

Federal Ministry for Economic Cooperation and Development
BMZ

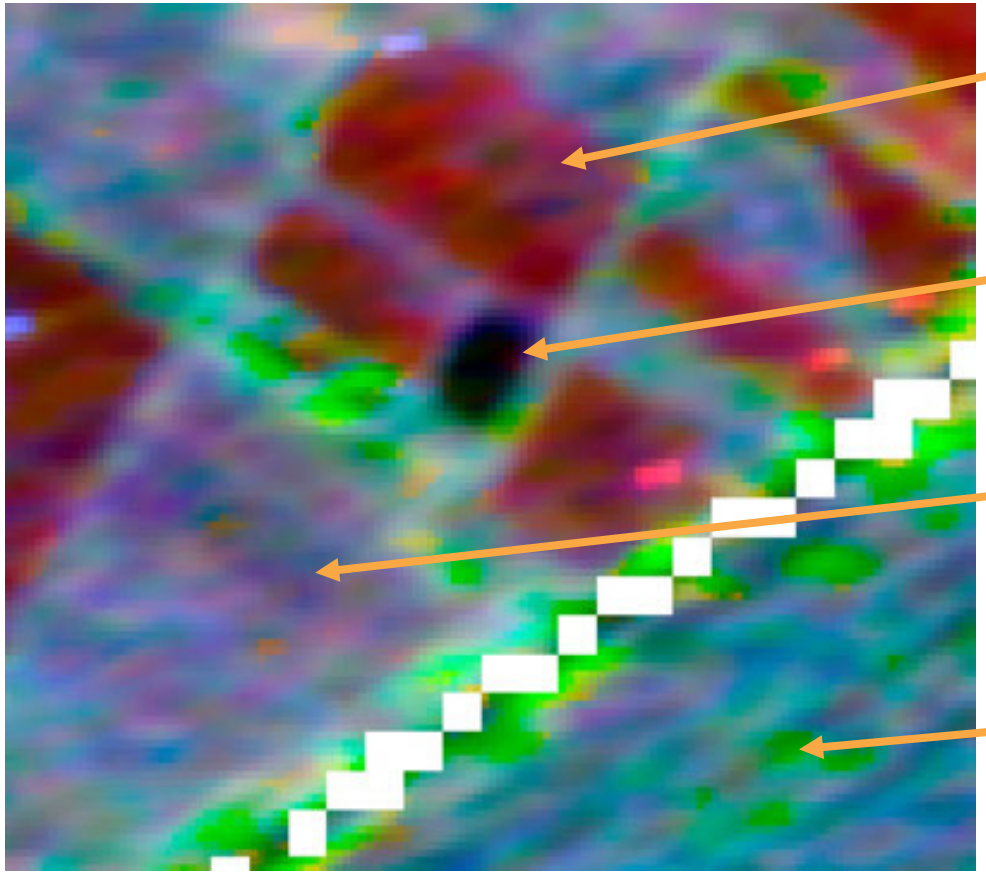
IRRI

Satellite Monitoring of Flooded/Dry Soil

Google Maps image 10°06'42"N
105°26'53"E

(1) “water body” in the center,
(2) “dry soil” in the bottom right,
(3) “paddy fields” in the top left

ALOS-2 image



“canopy on flooded soil”

“flooded/ water body”

“canopy on dry soil”

“dry soil”

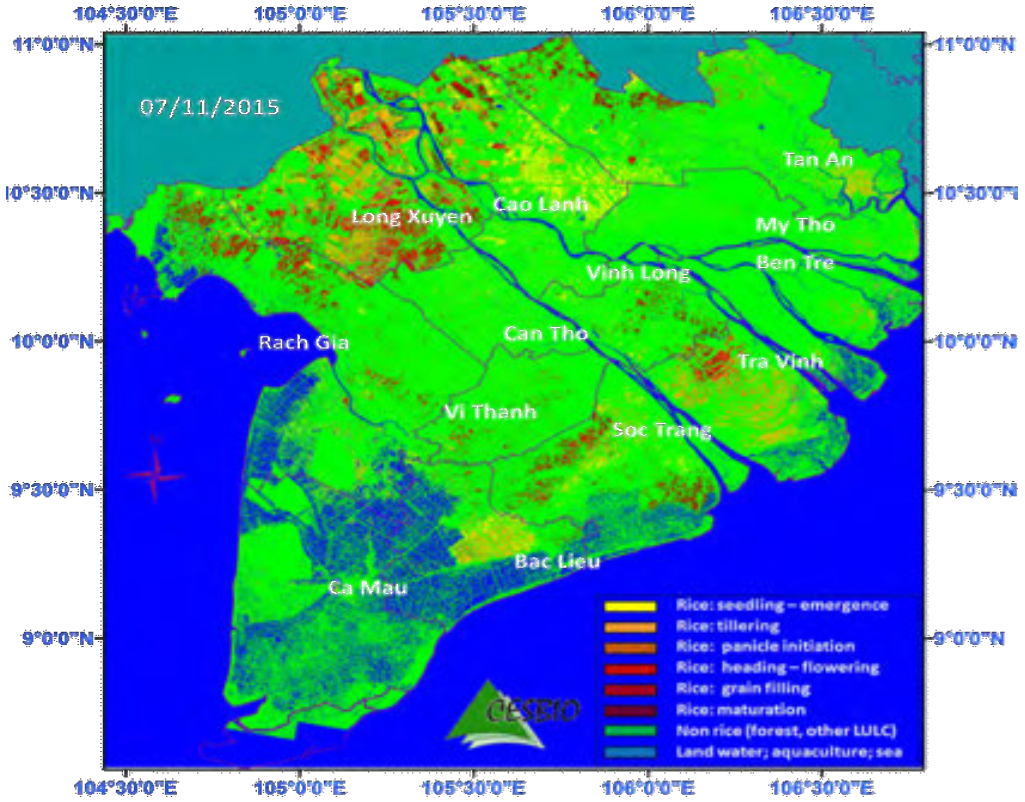
False-color overlay over the Google Maps image, showing the radar pattern.

double volume surface

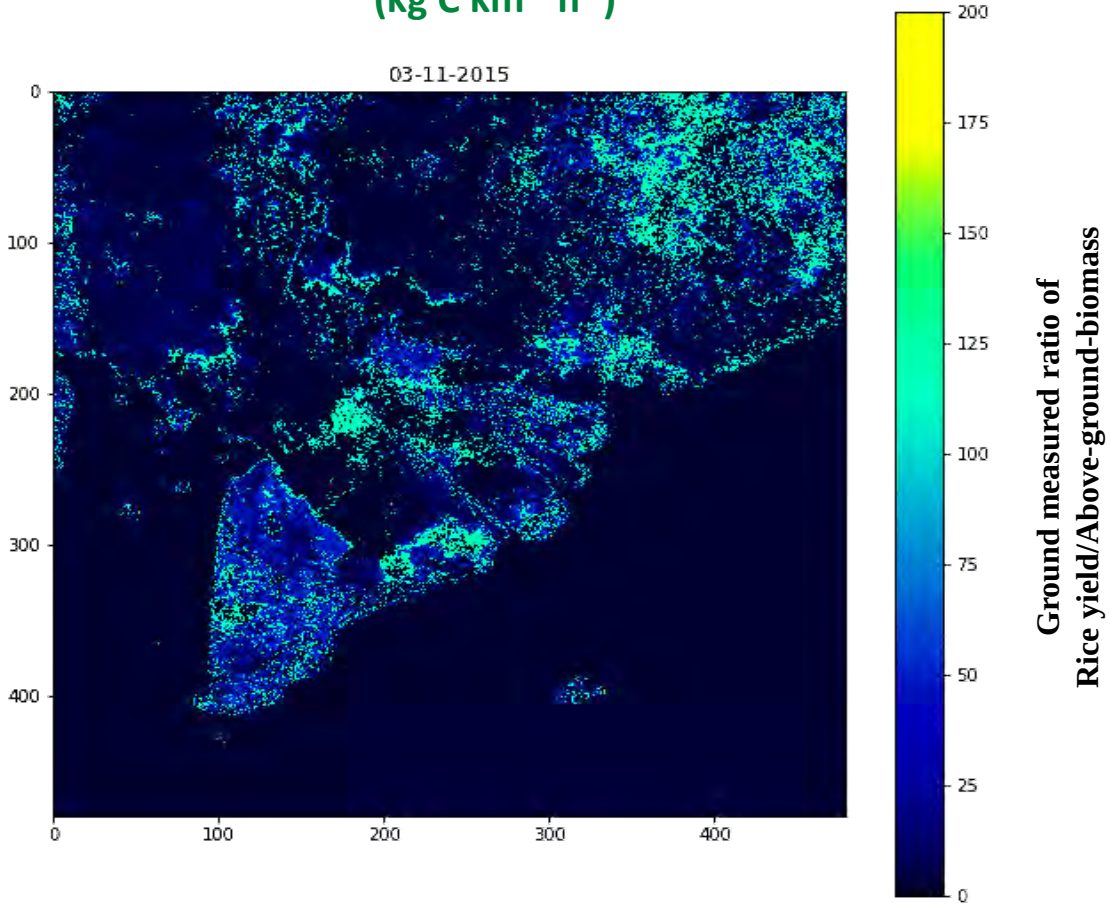
IRRI

Remote-Sensing and Modelling–based GHG Quantification (Tier 3)

Sentinel-1 to monitor rice growth



Simulated daily CH_4 fluxes (kg C km^{-2} h^{-1})



Arai et al., Springer, 2021

Based on assumptions for water and residue management!

Thank you

Web: www.irri.org

Contact:
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Senior Scientist and Representative to Thailand
International Rice Research Institute

IRRI International Rice Research Institute

IRRI is a member of the CGIAR