GEOGRAPHIC INFORMATION AND COMMUNICATION TECHNOLOGIES FOR SUPPORTING SMALLHOLDER AGRICULTURE

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Multiple factors constrain **smallholder agriculture** and farmer's **adaptive capacity** under the threat of **climate change**, including access to locally and context appropriate information to support decision-making. Current **geographic information** dissemination approaches to smallholders, e.g. the rural extension model, are limited, yet advancements in information communication technologies (ICTs) could help augment these processes through provisioning of **agricultural geographic information (AGI)** directly to farmers. **Research objective:** to critically reflect on recent AGI initiatives to identify opportunities for the success of future AGI developments.

Methods: We analysed recent ICT initiatives for communicating agro-climatic information to smallholder farmers reported in both academic and grey literature. Systematically assessing academic literature involved multiple keyword searches of the *Web of Science Core Collection* database, which focused on the topic areas of information, climate, and agriculture. We included only recent literature (published after the year 2000; to represent the period of relevant ICTs), in English language, and with full-text available. Resulting articles were read and either entered into a spreadsheet for analysis, or discarded if not relevant. Assessing grey literature involved identifying databases, sources, agencies, and other websites that may contain information on relevant community, agriculture and climate-related AGI initiatives. Database searches were filtered based on keywords to produce a subset for manual review. The inherently less systematic/automated means for assessing grey literature is noted as a limitation to results for inclusion in this paper from these sources; once a perceived cross-section of different types of initiatives was obtained the search was ceased. In total 27 AGI initiatives were identified and analysed for the paper.

Who are the target users of AGI initiatives and how have initiatives been adopted?

Initiatives largely targeted smallholder farmers and rural communities in the locations in the map below (number of initiatives per country). Low income farmers, fishing households, women, and progressive farmers were more specific targets of some initiatives. Adoption rates and effectiveness in terms of livelihood change were difficult to assess, with many initiatives merely self reporting number of users or platform downloads, for example.
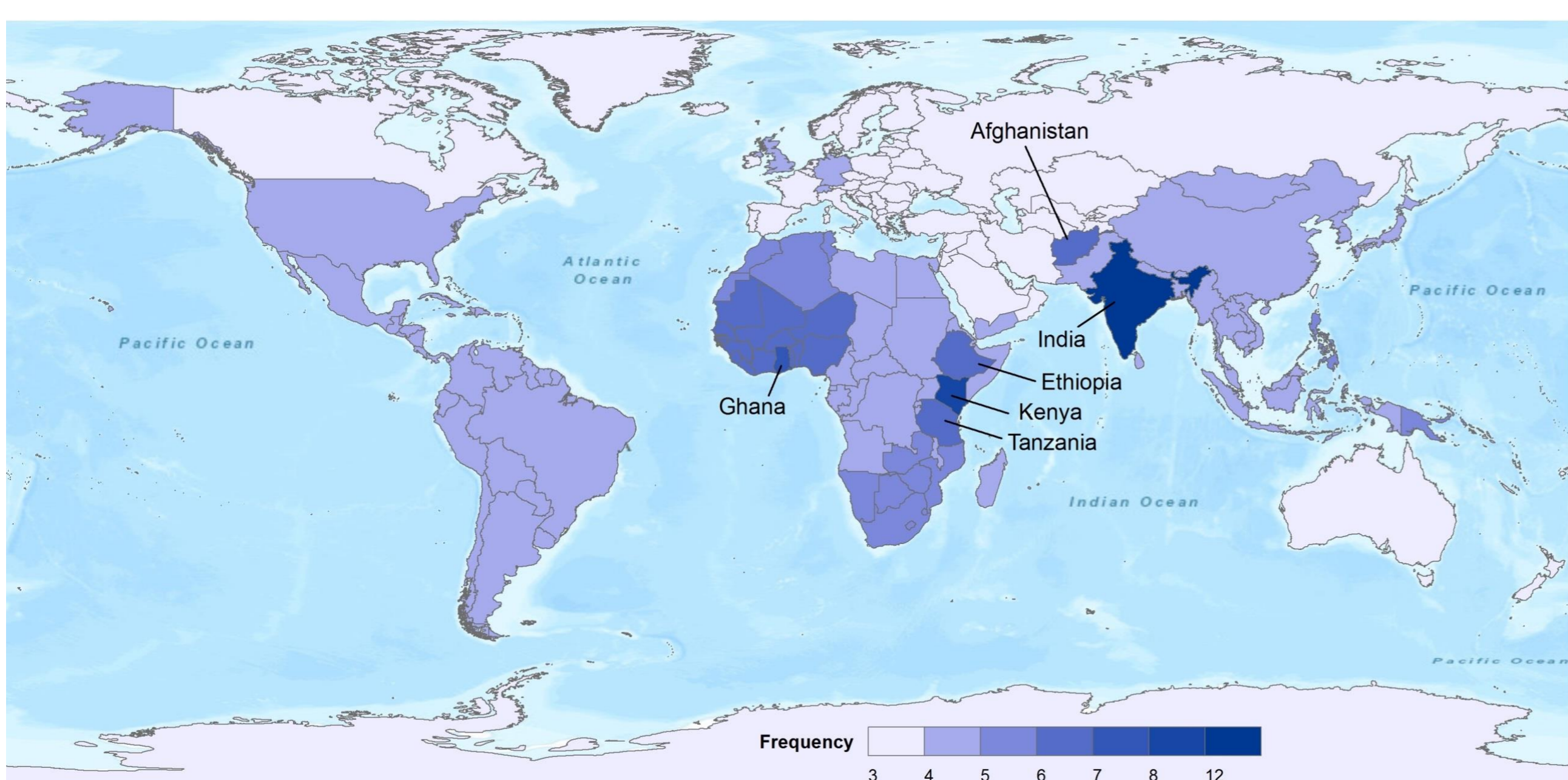
What key challenges have AGI initiatives aimed to address?

- Long term climate change impacts e.g. drought
- Short term shocks e.g. extreme/erratic weather
- Livelihood security
- Agricultural productivity
- Low income and food security
- Water management and monitoring

What technologies have been adopted to deliver AGI?

Technologies used in the analysed initiatives included: mobile phones/SMS (n=13), GIS (9), Internet/social media (9), smartphones/apps (7), imagery/remote sensing (4), web mapping (3), GPS (2), data modelling (2), radio communication (1), sketch/multimedia mapping (1), participatory videos (1).

What factors influence the success of AGI initiatives?

	Factors promoting success	Factors limiting success
Farmer capacity	Affordability to farmers	Participation capacity (exclusion through gender, costs, digital divide)
	Available languages	Limited languages
		Information alone often not enough for meaningful change
Approach	Partnerships with existing community groups	Methods for incorporating community knowledge into GIS
	User collaboration / sharing	Purely top-down approach – lack of interactivity
	Farmers involved in design	User registration required
Technological	High quality, locally-relevant information	Acquisition and sourcing of suitable and quality information/data
	Low tech and user friendly – ease of use	Availability and capacity of telecommunications infrastructure
	Allows participant feedback – interactivity functionality	Personal and community information security
Organisational	Organisational trust	Low user retention
	Potential for expansion – agile service	(In)ability to reach target users
	Marketing and endorsements	
	Clear business model, including funding	Funding of initiatives

Recommendations based on detailed analysis and critical reflection of initiatives in line with the questions above:
- AGI is not being delivered to many climate-impacted agricultural regions. Initiatives should be more effectively targeted to deliver AGI in regions aligned with those in most need of adaptation assistance e.g. SE Asia, the Pacific, Caribbean, and small island developing states (SIDS).
- Detailed appraisals of the strengths and weaknesses of modes of AGI delivery was lacking in initiative descriptions. Further analysis of the most effective technological approaches is needed.
- Initiatives should be independently assessed for evaluation of their uptake, success, and effectiveness to reduce self-reporting biases.
- Local communities should be better-incorporated into the development and use of ICT approaches for AGI to better align approaches with specific needs of those targeted and promote further community learning and information sharing.

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