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POLICY BRIEF
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Including Indigenous Peoples in Geospatial Services

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This article addresses the benefits and challenges to including indigenous peoples and their organizations as partners in the geospatial services provided by SERVIR-Amazonia, a USAID and NASA initiative implemented in six Amazon Basin countries: Brazil, Colombia, Ecuador, Guyana, Peru, and Surinam. It discusses who the Amazon indigenous peoples are, the significance and importance of their ancestral territories, and the benefits and importance to humanity of sharing and improving geospatial technology with them to help them defend and plan for the management and conservation of those territories. It also describes the challenges of engagement and communication with Amazon indigenous peoples, the need to work through the existing indigenous peoples' organizations (IPOs), and the importance of responding to their needs and priorities in a culturally sensitive manner with appropriate tools. Moreover, by identifying the issues involved and documenting the indigenous responses, the Program seeks to inform geospatial science and remote sensing technology with information that can help refocus their approaches to more effectively address the issues facing the indigenous peoples and their territories. The ultimate purpose is to help slow deforestation and biodiversity loss and diminish the impact of climate change, especially in the context of the COVID-19 pandemic.

Keywords: Amazon indigenous peoples, geospatial services, inclusion, monitoring, territories

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INTRODUCTION

The SERVIR Amazonia Program, part of the SERVIR Global network, is a joint USAID and NASA initiative to bring geospatial imagery from space to village in six Amazon Basin countries: Brazil, Colombia, Ecuador, Guyana, Peru, and Surinam. Its purpose is to facilitate partner efforts to address biodiversity loss, deforestation and forest degradation, as well as climate change mitigation. Program partners include government agencies, universities, and major civil society organizations. The original inhabitants and custodians of Amazon forests, savannas and waters are its diverse indigenous peoples. Much of the remaining biological diversity and intact primary forest are in the territories of the surviving indigenous peoples, and they are now seriously threatened by global extractive industries and organized crime. To help them defend and protect their territories and livelihoods, SERVIR-Amazonia includes indigenous peoples and facilitates their participation in Program services, complementing its gender equity efforts. In this article we highlight the cultural and technical issues that underlie the benefits and challenges of inclusion of Amazonian indigenous peoples and their importance for meeting program objectives.

METHODOLOGY

SERVIR-Amazonia's methodology is co-development of geospatial services in response to partners' needs and priorities and providing training and technical assistance to help them develop those services in accordance with their expressed needs. Indigenous peoples' Organizations (IPOs) now participate in six such services, originally designed for non-indigenous local partners in Peru, Brazil, Ecuador, Guyana and Colombia; new services directly with IPOs are being developed, beginning with the Madre de Dios Native Federation (FENAMAD) in Peru. Most IPOs are unfamiliar with available no-cost services, such as Global Forest Watch or the databases and mapping programs compiled by the different Amazon Basin government agencies and non-profit organizations. SERVIR-Amazonia technical assistance and training helps identify the technical and cultural challenges to fill those knowledge gaps and strengthen their ability to monitor and defend their territories, biological and cultural diversity as well as contribute to geospatial science and remote sensing technology by including indigenous peoples needs and priorities in their research agendas and technical practices and channeling indigenous feedback to improve the technical information and services.

AMAZON INDIGENOUS PEOPLES

Amazon indigenous peoples speak approximately 300 different languages within 50 genealogical units-−25 established language families and 25 isolates having no conclusively established relationship with other language families (Aikhenvald; Epps and and Salanova 2012; 2013, p. 1). Data on contemporary Amazon indigenous peoples by country are inconsistent, since governments lump Andean and indigenous peoples, and criteria on who are counted by censuses vary widely. The Coordination of Amazon Basin Indigenous Peoples (COICA) refers to more than 400 Amazon Basin peoples or nationalities[1]. Our estimate in 2021, which excludes peoples of Andean and other non-Amazonian origins, is compiled from a wide range of published and digital government and IPO sources; it estimates for each of the Amazon Basin countries the following numbers as of 2020, likely an undercount. **Table 1** below provides our best estimates.

Most of these indigenous peoples or nations live in traditional community territories or reserves. There are also dispersed indigenous families not recognized as communities, peoples or nations, and indigenous peoples who live in urban centers of their respective countries, usually not counted as indigenous peoples by the national censuses, but who serve as liaisons between their communities and the national society, economy, and political structures. Approximately 200 different indigenous groups are living in voluntary isolation in remote areas of Amazonia, where the lack of roads and government presence has allowed them to remain independent of national societies, mostly in border areas between Amazon countries (Huertas Castillo, 2002; Parellada, 2007; UNEP—United Nations Environmental Program, 2007; CIDH—Comisión Interamericana de Derechos Humanos, 2013; Shelton et al., 2013; IACHR—Inter-American Commission on Human Rights, 2018, p. 154–158).

Isolated indigenous peoples are not "uncontacted" peoples. All of them have been in historical contact with non-indigenous peoples and have been forced to seek refuge in the most isolated areas of the Amazon Basin to evade the epidemics, massacres, slaving forays, and the territorial dislocation that the invaders of their ancestral territories have brought. The governments of the Amazon countries have policies recognizing rights for them, including territorial reserves, but new aggressions into their territories by loggers, colonists, drug traffickers, gold miners, oil and gas companies, agro-industries, and others displace them from their refuges and threaten them with extinction (Soria Dall'Orso, 2020; Huertas Castillo, 2021).

AMAZON INDIGENOUS TERRITORIES

The map below includes the areas recognized in different forms by the national governments as indigenous territories in the nine Amazon Basin countries, shown in orange, as well as the natural protected areas (NPAs), which are also ancestral indigenous territories, shown in green. Most NPAs are not yet officially recognized by the respective governments as indigenous territories. **Figure 1** provides a map of indigenous territories, shown in orange, and natural protected areas, shown in green.

These areas are threatened by infrastructure projects and extractive industry concessions. Today, the tension between the ancestral ideal and the possibilities of territorial tenure are of critical concern and the subject of much internal discussion and territorial demands that include mapping of territories and challenges to illegal or undesired presences of outsiders. So, they are recurring to their IPOs to map and defend their territories.

INDIGENOUS ORGANIZATION

Amazon indigenous peoples' traditional social organization is kinship-based. Most Amazon indigenous peoples are egalitarian, lacking the internal social stratification and differentiation that is common in colonial or Western societies; there have been exceptions in pre-historic times (Moore 2020, p. 40–44).

Most Amazon indigenous societies are internally egalitarian, without hereditary chiefs or coercive authority. Indigenous leaders are recognized with prestige for their leadership skills, including productive capacity, family size, oratorical skills and ability to bring the group to consensus in disputes, as well as military skills. They resolve disputes by consensus (Clastres, 1974; Moore, 2021).

However, in response to external pressures Amazon indigenous peoples have organized formally, as territorial defense mechanisms, in accordance with the legal requirements of their respective countries. These new organizations, the IPOs, have evolved out of necessity. Initially they were associated local communities, but in the early 1980s, national federations of these organizations arose in each of the Amazon Basin countries, and in 1984, the Indigenous Coordination Organization of the

[1]Agenda Indígena Amazónica, https://coica.org.ec/agenda-indigena-amazonica/ (accessed January 14, 2022).

TABLE 1 | Indigenous peoples and estimated populations in the Amazon countries.

Country	Peoples or nations*	Individuals	Sources[a]	Dates
Bolivia	34	320,000	CIDOB, VMA, INE	2012, 2020
Brazil	256	950,000	COIAB, FUNAI, IBGE	2010, 2020
Colombia	26	52,000	OPIAC, DANE	2018, 2020
Ecuador	10	130,000	CONFENIAE, INEC	2018, 2020
French Guiana**	6	13,000	FOAG, INSEE	2018, 2020
Guyana	9	82,000	APA, 2012 Census	2012, 2019
Peru	51	550,000	AIDESEP, INEI	2017, 2020
Suriname	25	21,000	OIS, VIDS, ABS	2012, 2020
Venezuela	51	740,000	ORPIA, INE	2020
Totals	431***	2,858,000		

** Self-identification recognized by the IPOs.*

*** Overseas department of France, not an independent country.*

**** Peoples or nations registered in two or three countries are counted only once.*

[a] *IWGIA—International Work Group for Indigenous Affairs, 2021; Confederación de Pueblos Indígenas del Oriente Boliviano (CIDOB); Bolivia, Vice-Ministerio de Autonomías (VMA); Bolivia, Instituto Nacional de Estadística (INE); Coordenação das Organizações Indígenas da Amazônia Brasileira (COIAB); Brasil, Fundação Nacional do Indio (FUNAI); Instituto Socioambiental; Organzación de Pueblos de la Amazonía Colombiana (OPIAC); Colombia, Departamento Administrativo Nacional de Estadísticas (DANE); Confederación de Nacionalidades Indígenas de la Amazonía Ecuatoriana (CONFENIAE), Ecuador, Instituto Nacional de Estadística y Censos (INEC); Fédération des Organisations Amérindiens de Guyane (FOAG); France, Institut National de la Statistique et des Études Économiques (INSEE); Amerindian Peoples Association (APA); Guyana, Bureau of Statistics; Asociación Indígena para el Desarrollo de la Selva Peruana (AIDESEP); Perú, Instituto Nacional de Estadística e Informática (INEI); Organisatie van Inheemse Volken in Suriname (OIS); Suriname, Algemeen Bureau voor Statistiek; Organización Regional de Pueblos Indígenas de Amazonas (ORPIA); Venezuela, Instituto Nacional de Estadística (INE).*

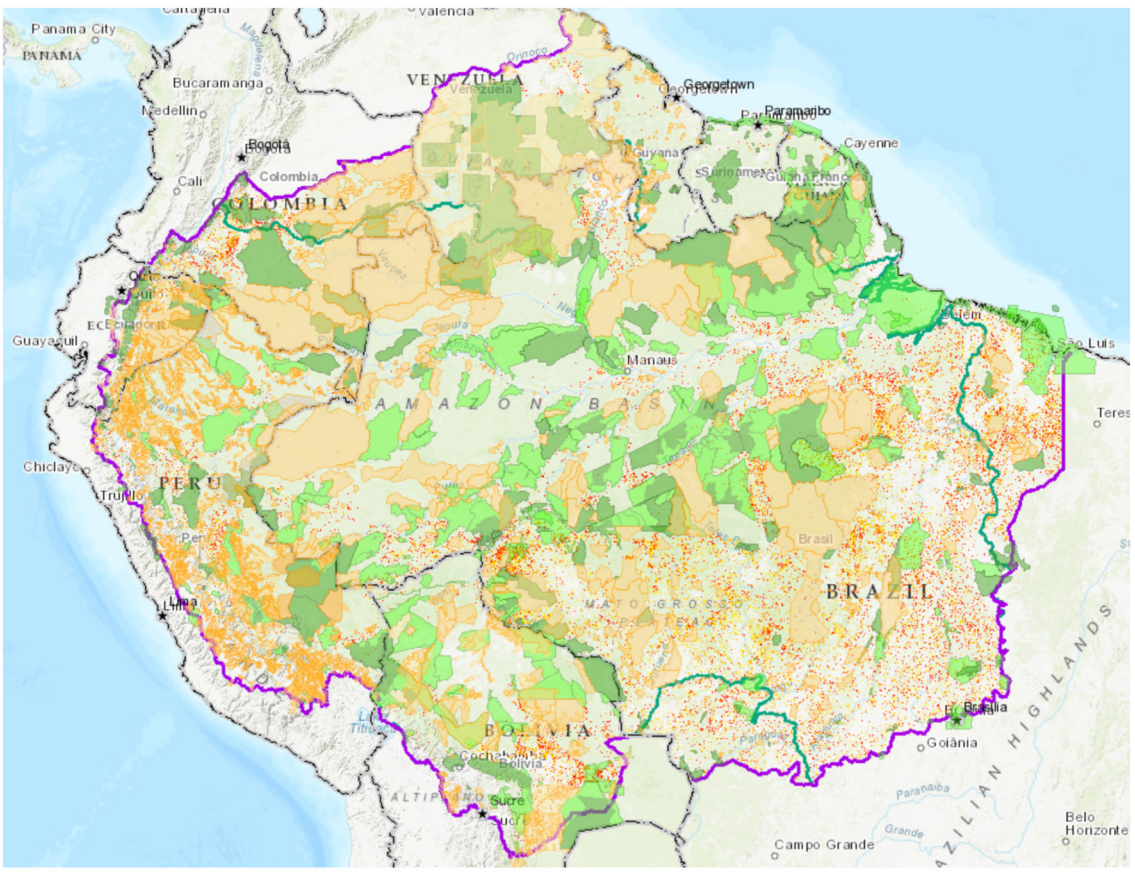

FIGURE 1 | Indigenous peoples' territories and natural protected areas in the Amazon countries. Source: Red Amazónica de Información Socioambiental Georreferenciada (RAISG). https://www.amazoniasocioambiental.org/es/mapas/. Reproduced with permission.

Amazon Basin (COICA) was founded to articulate the national-level federations for the entire region. Now, the IPOs have gained international presence, participating in the annual conferences of the United Nations Permanent Forum on Indigenous Issues, and in global conservation organizations.

ENGAGEMENT WITH AMAZON INDIGENOUS PEOPLES

SERVIR-Amazonia coordinates with the national-level IPOs and shares information with COICA. Some of them have attended SERVIR-Amazonia user needs and priorities workshops and made their priorities for geospatial services known. Others have participated in training events on geospatial images and technology.

SERVIR-Amazonia implements some geospatial services in places where it can strengthen the locally-based IPOs in areas of primary forest with high biological diversity and fragility from climate change. It has also recently begun training and technical assistance to the Madre de Dios Native Federation (FENAMAD) in the Madre de Dios watershed of southeastern Peru to help them strengthen their ongoing territorial monitoring program for indigenous community lands and forests. FENAMAD represents 38 indigenous communities in its region and also defends the rights of isolated indigenous peoples there.

Sierra Praelli (2019) describes threats to forests and community territories in Madre de Dios that FENAMAD seeks to defend with more effective territorial monitoring, mapping, and early alerts. SERVIR-Amazonia expects to develop similar experiences, tailored to local community needs, among indigenous peoples in the other Amazon Basin countries.

IPO NEEDS AND PRIORITIES FOR GEOSPATIAL SERVICES

The most urgent need expressed by the IPOs is for community territorial defense and land use planning. Once community volunteers with technical support from the IPO staff can identify the threats, locate them with UTM coordinates and satellite images, they will be able to communicate early alerts to the appropriate governmental authorities and the press as well as to their national and international allies, and adopt better self-defense measures, more effective control of the territories and better management of the ecosystems therein.

IPOs already use remote sensing information and mapping to support their demands before the corresponding government agencies for the titling of community lands that still lack titles, or, in Brazil, formalizing already demarcated indigenous lands. Geospatial information is also helpful in the development of community and organizational life plans (*planes de vida*) that have become requisites for subnational government support to community development projects. Other IPO needs refer to information to plan for, adapt to, or prevent forest fires, floods, and climate change impacts.

BENEFITS OF SHARING GEOSPATIAL SERVICE WITH IPOS

Historically, conservation initiatives have prioritized NPAs, but a recent report (ICCA Consortium 2021, p. 4) reveals that 45 per cent of the large Amazon wilderness areas are indigenous territories outside NPAs. Another study (FAO—United Nations Food Agriculture Organization FILAC—Fund for the Development of Indigenous Peoples of Latin America the Caribbean, 2021) shows lower deforestation rates and less risk of wildfires in indigenous territories than in the NPAs under government administration. In all of the earth's continents, human societies have employed ecologically transformative land use practices including burning, hunting, species propagation, domestication, cultivation, etc., over the past 12,000 years, that have left long-term legacies across the terrestrial biosphere, including 90 per cent of tropical woodlands (Ellis and Mahrabi, 2019). Land use transformations only became irremediably destructive in the twentieth and twenty-first centuries. Globally aggregated data for 38 million km^2 of lands managed by indigenous peoples in 87 countries in all continents reveal substantially greater sustainability in land use than for lands managed by non-indigenous holders (Fa et al., 2020).

These are some of the reasons why SERVIR-Amazonia and its associates need to engage the IPOs, partner with them to transfer geospatial technology, assist them in territorial monitoring and defense, help them prevent deforestation and adapt to climate change in critical areas, and learn from them. SERVIR-Amazonia's over-arching objectives are mitigating or adapting to climate change and preventing deforestation and biodiversity loss; so, efforts are needed in areas where success is more likely, the territories of life conserved by indigenous peoples.

Moreover, the technical assistance and training processes provide feedback to SERVIR-Amazonia that helps focus and orient the program. Early alerts issued by the trained forest monitors identify who is doing what, how, and why, complementing the imagery information that identifies forest/no forest characteristics. Such information not only allows for technical documentation of illegal activity that is used in legal procedures to control and sanction illegal activity in a transparent manner; it also eliminates unfounded accusations against communities engaged in legitimate clearing for horticultural and other traditional activities. Additionally, indigenous feedback can orient policy decisions by informing both the geospatial service provider and forestry authorities on indigenous cultural practices that limit deforestation and biodiversity loss and can help mitigate climate change if non-indigenous natural resource extractors adopt or adapt some version of them.

THE CHALLENGES

Programs like SERVIR-Amazonia work in national capitals and other urban centers where most of the government agencies, corporate headquarters, universities, and civil society organizations are. SERVIR-Amazonia's user needs and priorities workshops have been held in those cities, and subnational

governmental organizations, provincial universities, locally-based IPOs, and other civil society organizations have been underserved. Communication with communities in the interior of the Amazon Basin countries has been inadequate. For example, the Coordination of Brazilian Amazon Indigenous Organizations (COIAB), representing Brazil's Amazon IPOs, is located in Manaus, far from São Paulo, where the user needs and priorities workshop was held; so, they were unable to participate. Wi-Fi and telephone service coverage is unavailable in the remote areas where most of the indigenous peoples and their local IPOs are. The COVID-19 pandemic has seriously limited travel and communications with IPOs, but it has also led to an expansion of internet coverage in several Amazon countries to facilitate virtual public education. Many IPOs are now holding meetings over Zoom or similar platforms and improving their skills.

SERVIR-Amazonia offers IPOs cloud penetrating satellite data, like Synthetic Aperture Radar (SAR), and internet cloud-based solutions that no longer require the physical computer infrastructure of a few years ago to process large data sets. Internet cloud-based solutions allow for rapid processing of geospatial images and mapping, for a fraction of the cost of processing with high-end computer workstations. The use of this technology is still relatively new, the learning curve can be steep for many, and the lack of steady internet connections limits its widespread use for the time being. Privacy and security issues will likely limit cloud-based solutions, but these are some of the concerns under consideration. Undoubtedly, such geospatial solutions will prove extremely useful to IPOs once economic, cultural and digital barriers are overcome.

An important assessment of the utility of geographical information systems for Amazon indigenous peoples is Smith et al. (2003). Most of the remote sensing and mapping program use has been by the technical staffs of the non-indigenous NGOs on their behalf. SERVIR-Amazonia provides widespread, culturally sensitive training of community-level indigenous leaders and territorial monitors so that they may directly manage geospatial information. Now, most Amazon IPOs have some level of knowledge of geospatial images and mapping that they are using to plan their activities.

Indigenous people are keen observers and quick learners, who easily adapt new technologies to their needs. However, IPO leadership and staff skills and abilities to follow procedures developed by highly technical non-indigenous specialists are limited and those of local community forest monitors even more so. Most lack higher education and many of the language skills and cultural codes expected in the scientific and professional circles; so, they have difficulty following highly technical instructions.

Ethical issues include ownership of information, access to or exclusion from it, and uses that are made of it. Harttner et al. (2013) raise questions about culture change that the new technologies foster and the challenges of data sharing or not. Sletto (2009) and Múkaro Borrero (2016) express concerns about unintentional consequences of indigenous mapping that can divide areas identified with kinship-based groups, and fix boundaries where previously there have been none, in culturally inappropriate manners.

SERVIR-Amazonia is consolidating its strategy to overcome these challenges. It has deployed its indigenous peoples' advisor to work directly with the IPOs in their areas. It uses trainers who have prior experience working with indigenous peoples, and are sensitive to cultural and linguistic issues. Training exercises take these conditions into account and proceed with patience and sympathy, in continuous dialogue with the IPOs. The Program is coaching trainers on indigenous perspectives on their territories and their priorities and reviewing training and technical assistance plans constantly to improve communication and strengthen indigenous options for response to the threats to their territories.

It provides tools to the IPOs free of charge and respects their desire to grant or exclude access to the information derived from them, considering their security and privacy needs. Most Amazon IPOs prefer not to share digital information on their territories with government databases that they perceive may be used against them. The community lands are already mapped for land titling; geospatial information helps better define the established boundaries. SERVIR Amazonia provides support to forest monitoring and early alert activities already underway with the IPOs under their leadership. It jointly develops data governance protocols with the IPOs to be shared, understood, and applied by its indigenous partners. It also works with the IPOs to develop proposals for international cooperation funding that can cover salaries for IPO staff engaged in geospatial services and community or regional mapping, improved information technology infrastructure and other material needs to complement the training and technical assistance that it can provide.

Satellite imagery data are being used by indigenous communities and their IPOs to document criminal charges against illegal invaders of their territories; security risks must be taken into consideration.

CONCLUSIONS AND RECOMMENDATIONS

Conservation programs in the Amazon Basin have long neglected indigenous peoples' territories. Reaching those territories requires engagement with and inclusion of the indigenous peoples themselves, through their organizations, understanding and respecting their conservation ethos, and adapting technology supply to existential and practical demand to help them defend their territories.

SERVIR-Amazonia is implementing appropriately tailored training and technical assistance to IPOs in strategic areas of other Program countries, and is engaging local IPOs in its other services where appropriate. The results, once attained, promise to be well worth the effort and

should contribute to sound management of tropical forest ecosystems. They will also demonstrate the importance and value of the inclusion of Amazonian indigenous peoples, sharing useful technology with them, and learning new skills and environmental relationships from them in ways that challenge conventional wisdom on natural resource use.

Techniques and procedures developed by SERVIR-Amazonia should not be applied mechanically as one-size-fits-all methodology. They may orient work with other indigenous peoples, but cultural differences and different priorities must be considered.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work and approved it for publication.

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