Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya

Mitchelle Chao MTWANGUO, Kenya and Collins MWANGE, Kenya.

SUMMARY

The paper discusses the importance of literacy in achieving the United Nations Sustainable Development Goals, specifically in the context of rural communities such as Taita Taveta County in Kenya. Despite efforts to improve education and access to quality schooling, disparities in literacy rates persist, often due to factors such as poverty, lack of infrastructure, and limited resources. Assimilation of scientific and technological approaches, such as Geographic Information Systems, can provide a more accurate and comprehensive understanding of literacy levels in these communities. This paper outlines the approach used to map the location of the schools, literacy, terrain, and population settlement in Taita Taveta County. It highlights the significant disparities in literacy and school enrollment between different types of educational institutions, contributing factors and interventions to address literacy challenges. It concludes by emphasizing the need for practical and accessible literacy assessment tools for rural communities in Kenya and other similar contexts, ensuring progress is made towards achieving universal literacy and quality education.

Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
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Orlando, Florida, USA, 28 May–1 June 2023

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1. Introduction

This study aims to address the issue of declining education standards in Taita Taveta County, a rural county in Kenya, by assessing the literacy levels of school-going children. The Basic Education Act of Kenya mandates that every child has the right to free and compulsory basic education (Ministry of Education, Science and Technology , 2014). The United Nations Sustainable Development Goal 4, Quality Education, aims to provide equal access to affordable vocational training, eliminate gender and wealth disparities, and achieve universal access to quality education. However, there are significant literacy and education disparities between rural and urban communities. In Sub-Saharan Africa, 88% percent of children (approximately 202 million) of primary and lower secondary school age were not proficient in reading in 2015 (United Nations Statistics, 2016).

With this in mind, the study sets out to use Geographic Information Systems as a data analytics tool and decision support system to spatially assess factors affecting literacy directly and indirectly. This will provide strategic methodologies aimed at improving both literacy and quality of education in rural communities. By providing descriptive information on school distribution, population settlement, and literacy trends in the study area, the study will contribute to achieving the goal of quality and inclusive education for all by 2030.

1.1 Scope of Study

Taita Taveta County in the Kenyan Coastal region is the focus of the case study. It covers an area of 17,083.9 km², characterized by diverse climate and terrain. The elevation ranges from 308m to 2208m above sea level. As a result, the terrain and climate influences settlement patterns, population distribution, infrastructure interconnectivity, and location and distribution of amenities and economic resources. About 11,110 km² is occupied by Tsavo East and Tsavo West National Parks making it a tourist destination. Taita Taveta County is predominantly rural, with a population of approximately 340,671 according to the 2019 Kenya National Population Census. The majority of the population is made up of the Taita and Taveta communities who primarily engage in subsistence agriculture and pastoralism and is home to migrant ethnic communities including the Kamba, Kikuyu, Luo, and Maasai among others. The county has limited road networks and transport systems, posing a significant challenge to access to education and other amenities. The poverty level in the county is quite large at 57.2%, further exacerbating the already low literacy levels (County Government of Taita Taveta, 2019).

Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
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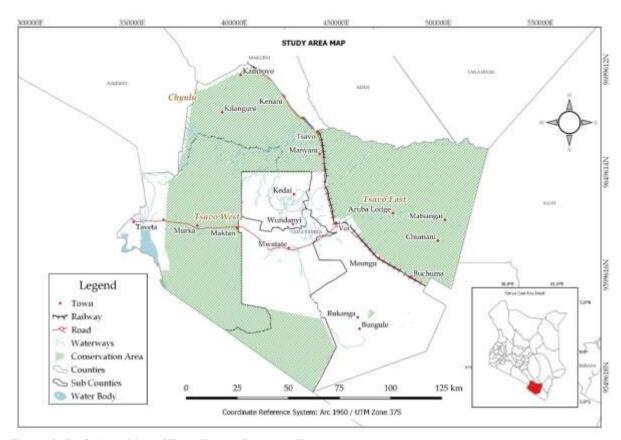Orlando, Florida, USA, 28 May–1 June 2023

Figure 1: Study Area Map of Taita Taveta County in Kenya

2. An Overview of Literacy Policy, Assessment and Practice in Kenya

Literacy is an essential skill that encompasses not only reading and writing but also numeracy and communication. It is a lifelong learning process that empowers individuals to achieve their goals, develop their potential, and participate in their communities and societies. Literacy is a fundamental aspect of education and a key driver of sustainable development (Montoya, 2018).

2.1 Literacy assessments and interventions in Kenya

In the 1960s, Kenya's focus was on eradicating illiteracy through literacy campaigns. The Kenyan government launched the National Literacy Campaign in 1967, which aimed to eradicate illiteracy. In 1972, the Experimental World Literacy Programme was introduced with the support of UNESCO, which focused on functional literacy that involved practical and basic literacy through income-generating projects. However, this initiative resulted back to basic literacy in the 1980s, which led to further endorsement from the Kamunge report (Bunyi, 2006).

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Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

Measuring literacy is a complex exercise. There is no direct method of measuring literacy rates since they are considered proxies that indicate literacy skills. The most common methods used in Kenya include literacy tests and surveys, self-reporting, education attainment, and indirect estimates. These methods have inconsistencies and challenges, leading to the development of worldwide assessment surveys, such as the Program for the International Assessment of Adult Competencies (PIAAC), Literacy Assessment and Monitoring Programme (LAMP), and the Adult Literacy and Life Skills Survey (ALL).

Kenya participated in the LAMP, but after two years of participating, issues arose in the development of data taking too long, the methodology being expensive, and the assessment items and tools not being culturally relevant to the country. Later, techniques and methodologies from LAMP and Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) were developed, leading to the Kenya National Adult Survey in 2006, carried out by the Kenya National Bureau of Statistics (KNBS) in collaboration with UNESCO and the Department of Adult Education. (People's Action for Learning)

The survey showed that 7.8 million youth and adults were illiterate in Kenya, with a national adult literacy rate of 61.5% and a numeracy rate of 64.5%. There was a literacy rate of 69.1% in the age group of 15-19 years, indicating that 29.9% of this population were illiterate. Women participated more in adult literacy programs as they exhibited low numeracy, reading, and writing skills compared to men. Rural areas recorded lower literacy levels compared to urban areas, with economically well-off communities having a better chance of better academic and literacy achievements compared to those affected by poverty. The survey indicated that 38.5% of the population was termed illiterate, and only 31% were aware of the existence of ACE programs despite their availability of at least one center in each administrative location. (Kebathi, 2008)

In 2015, Uwezo Kenya released its fourth learning assessment report, with a focus on Goal Six of the Education for All Goals. The assessment measured the learning abilities of grade 3 children in Kenya, to read and comprehend English and Kiswahili and complete basic numeracy tasks at the grade 2 level. Uwezo reported a national average of 32%. The report findings indicated: there was a lack of progress in learning and persistence of gender and geographic disparities affecting learning outcomes. The report also revealed an increase in the number of teachers and students attending school. However, a significant number of students were still dropping out of school, despite an increase in enrollment in the 3-5 age group (Twaweza East Africa , 2014).
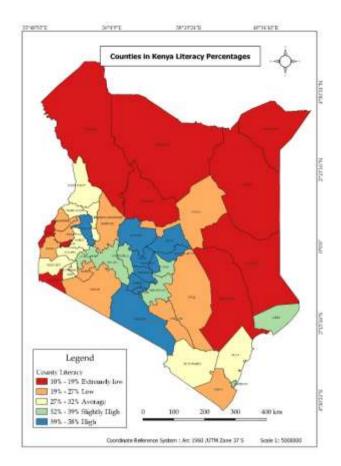
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FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

Figure 2: Literacy Percentages of Counties in Kenya as per Uwezo 2014 Learning Assesment

County	Literacy %	County	Literacy %	County	Literacy %
Baringo	26	Kisii	30	Nandi	32
Bomet	21	Kisumu	31	Narok	20
Bungoma	23	Kitui	26	Nyamira	30
Busia	17	Kwale	27	Nyandarua	36
Elgeyo Marakwet	28	Laikipia	39	Nyeri	58
Embu	34	Lamu	37	Samburu	13
Garissa	17	Machakos	37	Siaya	25
Homabay	22	Makueni	27	Taita Taveta	29
Isiolo	24	Mandera	10	Tana River	18
Kajiado	54	Marsabit	18	Tharaka Nithi	39
Kakamega	24	Meru	42	Trans Nzoia	28
Kericho	33	Migori	18	Turkana	14
Kiambu	54	Mombasa	38	Uasin Gishu	39
Kilifi	32	Nairobi	42	Vihiga	19
Kirinyaga	42	Nakuru	35	Wajir	18
				West Pokot	28

Table 1: Kenya Counties and literacy level percentage as per Uwezo 2014 Learning Assessment among Standard 3 children.

Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

Three interventions were launched in 2015 to improve basic literacy and numeracy skills in Kenya. The first intervention was the Tusome program, initiated by Research Triangle International and the Kenyan Ministry of Education, Science and Technology. The program seeks to improve reading among Standard 1 and 2 children by enhancing teaching reading methods, providing increased teacher support and supervision. The second intervention, Tayari, aims to improve pre-literacy skills among children in pre-school to enhance their readiness to learn, also initiated by Kenyan Ministry of Education Science and Technology and Research Triangle International. The third intervention is a collaboration with the Global Partnership of Education and the Kenyan Ministry of Education, which focuses on improving numeracy skills among grades 1 and 2. These interventions aim to address the disparities and improve learning outcomes in Kenya (Twaweza East Africa , 2014).

2.2 Education Expenditure in Kenya

Education expenditure is vital to improving literacy needs and levels in the country. In 2006 when the Kenya National Adult Survey was being carried out, the Kenyan government education expenditure was 1,820.7 million US dollars, 25.08% of the national budget was allocated to the education expenditure, 7.05% of the nation's Gross Domestic Product (GDP) was allocated to education expenditure, the national literacy rate in 2006 was 61.5%. In 2018, the education expenditure was 4,671.2 US million dollars, with 19.10% of the national budget allocated to education expenditure and 5.32% of the Gross Domestic Product (GDP) was allocated to education expenditure, the national literacy rate is 81.54%. As the government increased its education expenditure, the literacy rate in the country significantly improved, further indicating a positive relationship between government investment in education and improvements in literacy rates. Investing in education is crucial for improving literacy levels in the country, and the increase in education expenditure over time has resulted in a notable increase in the national literacy rate (Kenya - Government Education Expenditure 2018, 2018) Currently, Kenya's literacy rate is at 78% (World Bank, 2018).

2.3 The Role of GIS Technology in Education Planning and Management

Use of Geographic Information Systems, (GIS) technology integrates geographic science understanding and collaboration to process data and generate easily accessible and updateable map outputs. The School Mapping Project is a case study of GIS in education planning and management, which involves building geospatial databases of educational, social, economic, and demographic data to support educational planning and decision-making. (Mulaku & Nyadimo, 2011)

The Kenyan School Mapping Project was initiated as part of the Kenya Education Sector Plan to collect data on all Kenyan learning institutions and eventually integrate them into a GIS database. The specific objectives of the Kenya School Mapping Project were to spatially locate all educational institutions, collect supplementary attribute data using a questionnaire, set up a GIS database at the Ministry of Education, and produce digital maps and other by-products derived from GIS analysis and query on all the educational institutions. (Mulaku & Nyadimo, 2011)

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FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

Similarly, Nepal implemented the school mapping concept in educational systems in conjunction with the National Education System Plan to prepare district-level maps depicting the distribution of education facilities. GIS is crucial in Education Management Information Systems through school mapping projects to meet disparities in access, quality, equity, and management concerns. (Banksota)

3.0 Opportunities in Enhancing Literacy Assessment through GIS Technology

GIS technology can be used in both school mapping and literacy assessment to collect and analyze spatial data. School mapping involves building geospatial databases of educational, social, economic, and demographic data for educational institutions to support educational planning and decision-making. GIS technology can be used to spatially locate all educational institutions, collect supplementary attribute data, set up a GIS database, and produce digital maps and other by-products derived from GIS analysis and query on all the educational institutions. On the other hand, GIS technology can also be used in literacy assessment to collect and analyze data on the literacy levels of different regions, communities, and populations. This can help education planners and policymakers to identify areas where literacy levels are low and target resources and interventions to improve literacy outcomes. In summary, GIS technology is a useful tool for both school mapping and literacy assessment as it enables the integration of various data and generates easily retrievable, updated, and edited maps that can be shared and accessed anywhere and everywhere on multiple devices. While the specific applications of GIS technology in school mapping and literacy assessment may differ, both can benefit from the use of this technology to collect and analyze spatial data.

3.1 Factors affecting Literacy in the area of study

The following factors, accompanied by relevant maps, highlight the variables that contribute to literacy in the study area

3.1.1 Terrain and Climate

Diverse climate and terrain directly affects population density, influencing settlement patterns and distribution of social amenities like transport infrastructure and learning institutions. The terrain of Taita Taveta County includes mountains, valleys, and plains. In mountainous areas, it is challenging to build and maintain roads, limiting access to schools and other educational facilities, lowering literacy rates among the population living in these areas.
The terrain impacts the students travel distance to school. In areas where schools are located far away from residential areas, children may be less likely to attend school, leading to lower literacy rates. Remote areas that may be inaccessible or unsafe, particularly during the rainy season when landslides and flooding can occur, making it challenging for students to travel to school, leading to lower literacy rates.
Terrain can also affect access to educational resources. For example, schools located in remote areas may not have access to libraries, computer labs, or other educational resources that are available in urban areas. This can limit the quality of education provided and lead to lower literacy rates.
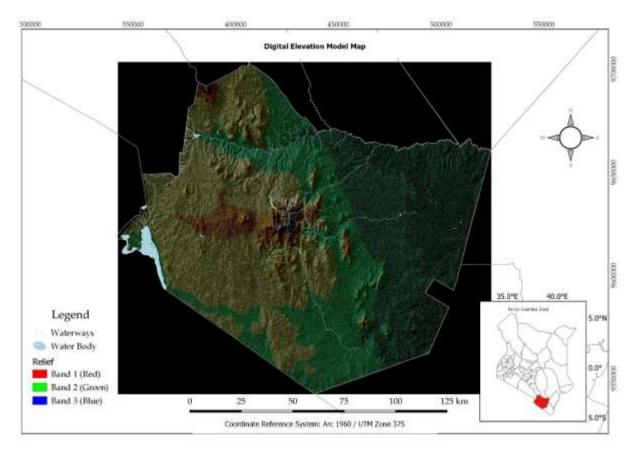
Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

Figure 3 Digital Elevation Model of Taita Taveta depicting terrain

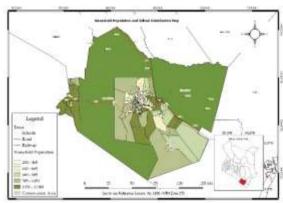### 3.1.2 Population and Household Distribution

Population and household distribution can affect education and literacy levels by impacting the accessibility of schools, the quality of education provided, the distance between households and schools, gender disparities in education, and economic status. In areas where households are more dispersed, it may be more challenging to provide access to education facilities such as schools, leading to lower literacy rates as children may not have access to schools.

Areas with few or overcrowded schools, might have compromised quality of education leading to lower literacy levels.

The distance between households and schools can also affect education and literacy rates. Children who live far from schools may face challenges in attending school regularly, leading to lower literacy levels.

The distribution of households can also affect gender disparities in education. Girls in more remote areas may be less likely to attend school, leading to lower literacy rates among women.

The distribution of households can also affect economic status, which can in turn affect access to education. In areas with a higher concentration of low-income households, children may not

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Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

have access to educational resources, such as books or computers, which can lead to lower literacy levels.
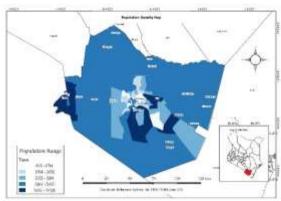

Figure 4: Household Population and School distribution

Figure 5: Population Density Map

3.1.3 School Enrollments

Availability of schools directly translates to school enrollments as shown in the below school enrollment maps. Schools in Taita Taveta are the main source of education and literacy activities, thus critical factor in determining literacy rates and overall education outcomes.

Availability of a proper transport infrastructure is a fundamental factor in determining physical accessibility to education and literacy activities. However, most of the roads in the county are unclassified and poorly maintained, resulting in poor service accessibility and delivery.

Availability of schools evenly distributed within the population settlement significantly reduces the rate of school truancy and dropouts, teenage pregnancy and child marriage, child labor and addresses gender parity in education. Increased school enrollments lead to improved literacy levels and education outcomes.

The quality of education provided by learning institutions is also a critical factor in determining literacy rates. Schools that provide high-quality education can improve literacy rates and overall educational outcomes.

Provision of libraries and resource centers contributes to socio-economic development by empowering and improving skills in the workforce, enhancing research improve quality of learning.

It is worth noting the decrease in school distribution leading to low enrollment, as the education level rank. The study area has more pre-primary and primary school institutions and fewer secondary schools and tertiary education institutions. Availability of Adult Education Centers indicates enrollment in adult education and literacy activity and services, which can be used to improve literacy among adult populations. Tertiary education institutions in the study area are limited in number and location distribution. There is only one university and few youth polytechnics.
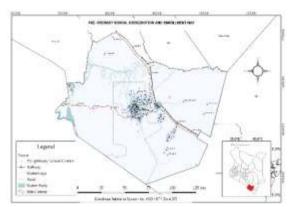
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FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023
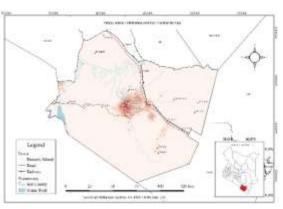
Figure 6: Pre-primary School Enrollment

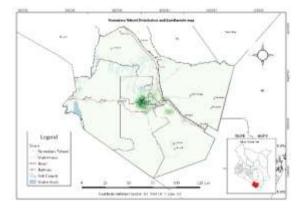*Figure 7: Primary School Enrollment*
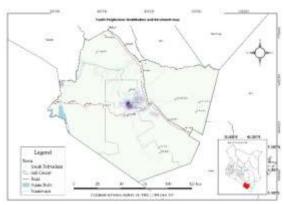

Figure 8: Secondary School Enrollment
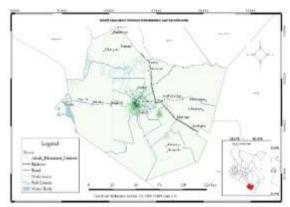

Figure 9: Youth Polytechnic Enrollment

Figure 10: Adult Education Centers Enrollment

Figure 11: University Enrollment

Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

3.1.4 Poverty

66% of the population in the county live in poverty and sustain their livelihoods through subsistence agriculture. Majority of the parents and guardians are not able to provide supplementary learning material for their children and solely rely on learning material provided by the Government in public schools for learning activities. In 2013,The County Government of Taita Taveta mandated The Primary School Taskforce to investigate the declining state of education and below average performance in national examinations in the county . The Primary School taskforce indicated poverty, lack of well-equipped facilities in the school, lack of basic equipment and learning material in the schools like books and stationeries as leading factors to the dwindling state of education. (Primary School Taskforce, 2013)

4.0 Conclusions, Interventions and Recommendations

The rural communities of Kenya face unique challenges and require tailor-made policies and solutions that take into account their culture, norms, and existing disparities. Literacy is a crucial component of education, yet literacy assessment, practices, and interventions have not been given enough attention in the 21st century. There is a need for improved data collection and streamlined data to inform policies, interventions, and practices. Rural communities require engagement of community members in literacy and education activities and interventions due to their specific needs and demands. In Taita Taveta County, poverty has a significant impact on education, particularly in terms of digital literacy, school infrastructure, pupil to teacher ratios, school feeding programs, access to learning materials, extra-curricular activities, and quality of education. The COVID-19 pandemic has exacerbated these challenges and led to a negative impact on education interventions and progress to achieve high-quality education in accordance with Sustainable Development Goal 4, it is important to conduct accurate and specific literacy assessments. This study shows that science and technology can be helpful in achieving this goal. Additionally, further research should be conducted on topics such as literacy, literacy assessment, data collection and analysis, and policy guidelines and methods.

4.1 Literacy Interventions in Taita Taveta

Improving literacy rates in Taita Taveta will require a multi-faceted approach that addresses the many complex factors that contribute to low literacy rates in the region.
Increasing access to education could involve building more schools, providing transportation for students who live far away, and hiring more teachers to reduce class sizes.
Training teachers on effective teaching methods, providing them with resources and materials, and ensuring that schools have adequate facilities and technology could improve the quality of education.
Poverty and inequality are major barriers to education in Taita Taveta, and addressing these issues could help to improve literacy rates. This could involve creating more job opportunities, providing access to healthcare, and implementing social safety nets for vulnerable population

Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

Encouraging community involvement by including parents and community members in the education process could help to improve literacy rates. This could involve creating community-based programs that support learning outside of school, such as adult literacy classes, tutoring programs, and community libraries.

Providing targeted interventions based on the specific factors affecting literacy could help address disparities. An example of target interventions are school feeding programs, school libraries, sports and extra-curricular activities and school clubs.

4.2 School Libraries as Interventions to address Literacy and Education Disparities

Government and education stakeholders should invest in building and equipping more libraries in schools, and collaborating with community libraries and organizations to support literacy and education development in the community.

Ensuring that school libraries have sufficient and diverse collection of learning materials, including books in local languages and providing training to librarians on how to effectively support students' literacy development which instills a love for reading and research among students encouraging their critical thinking and analytical skills.

School libraries could also serve as a hub for teacher training and development, providing access to relevant teaching materials and resources to improve their instruction

Adults who may not have had the opportunity to access education earlier in life can benefit from the resources available in school library. School libraries can serve as community resource centers by providing access to information on relevant topics and serve as activity hubs by providing space for the community to gather for community activities and events. (Chao and Friends Foundation, 2018)

In Taita Taveta County, Chao and Friends Foundation is setting up school libraries in primary school as a targeted intervention to addressing literacy and education disparities, significantly improving learning and education outcomes in the community.

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Use of Geographic Information Systems (GIS) to Assess Literacy in Rural Communities in Kenya (12181)
Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
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Orlando, Florida, USA, 28 May–1 June 2023

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BIOGRAPHICAL NOTES

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Mitchelle Chao Mtwanguo and Collins Mwange (Kenya)

FIG Working Week 2023
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