RESADE-CARI PROJECT NEWSLETTER

The birth of soil salinity Research in Liberia, West Africa

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Abstract

Salinity research in Liberia has emerged as a significant area of investigation due to the escalating challenges of salinization, particularly in coastal regions and irrigated agricultural lands. The necessity for such research became apparent as environmental changes, including climate change and anthropogenic activities, have adversely affected soil and water quality in Liberia. A thorough understanding of salinity levels is imperative for promoting sustainable agriculture, managing ecosystems, and addressing food security concerns.

The inception of salinity research in Liberia marks a vital advancement in addressing environmental challenges that jeopardize both natural ecosystems and agricultural productivity. Continued research efforts will be essential in developing effective management strategies that foster sustainability and enhance resilience against climate-related impacts on agricultural productivity within the region.

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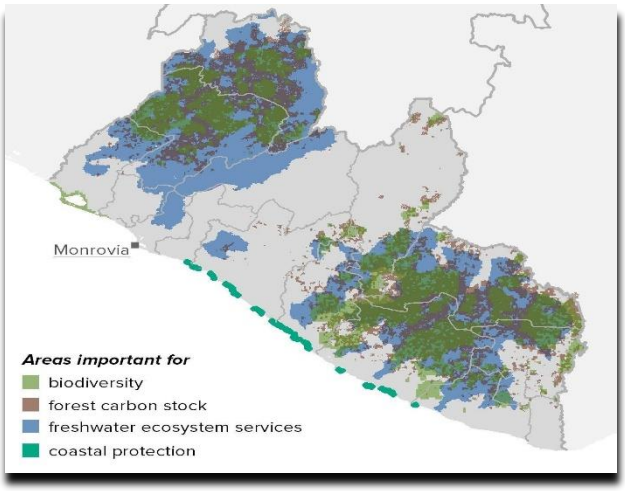
1.0 Background

Liberia, the oldest independent country on the African continent, is rich in natural resources, including arable land, minerals, and rainforests. The country is divided into fifteen counties, nine stretching along the Atlantic Ocean and six counties located inland. Liberia has a monsoon climate and features four distinct types of topography: the coastal plain (up to 25 miles inland), rolling hills (300 feet above sea level), plateaus (1,000 to 2,000 feet above sea level), and northern highlands (4,000 -4500 feet above sea level).

Founded by a group of freed American slaves, Liberia has struggled to produce enough food to sustain its population, which is estimated at 5.5 million people. This inability to achieve food security can largely be attributed to inadequate support for agricultural development, including research and extension services. Additionally, farming practices in the country are primarily rudimentary and dominated by a slash-and-burn method, resulting in significantly low yields from farmers' fields.



Liberia Natural resources Map

Liberia population map

Agriculture is essential for over 70% of the population in Liberia, but it faces numerous challenges. These include poor infrastructure, limited human resource capacity, inadequate government support, weak farm-to-market linkages, pest invasions, and soil-related issues like aluminum and iron toxicity. Additionally, climate-related challenges such as droughts, flooding, and strong winds complicate the situation further.

Challenges facing Agriculture in Liberia

Bad Roads limit access to market

1.1 Introduction

Salinity research in Liberia has become increasingly urgent as environmental changes, including climate change, rising sea levels, and human activities like deforestation and unsustainable farming practices, have significantly impacted soil and water quality across Liberia.

Salinity, which refers to the concentration of salts in soil and water, can have detrimental effects on agricultural productivity. For several reasons, it is essential to understand and monitor salinity levels. First, high salinity can lead to reduced crop yields, affecting food security and the livelihoods of farmers who rely on consistent agricultural output. Second, salinization can disrupt local ecosystems, leading to loss of biodiversity and degradation of natural habitats. Therefore, the implications of salinity extend beyond agriculture into broader environmental and socioeconomic realms.

The establishment of salinity research in Liberia represents a crucial step towards effectively addressing these environmental challenges. Through comprehensive studies that assess salinity levels and their impacts, researchers can develop a better understanding of how these issues develop and how they can be managed. This knowledge is particularly important for creating informed strategies that promote sustainable farming practices, such as the use of salt-tolerant crop varieties and enhanced irrigation techniques.

Furthermore, ongoing research will play a vital role in formulating effective management strategies that bolster both agricultural sustainability and ecosystem resilience. This is particularly relevant in the context of climate change, as increasing temperatures and erratic rainfall patterns can exacerbate salinity issues. By focusing on this research, Liberia can work towards ensuring food security, protecting its rich biodiversity, and fostering sustainable development that can withstand the impacts of climate-related changes in the future.

2.0 The future effects of soil salinity on agriculture land in Liberia

One significant issue that has largely gone unnoticed in Liberia is soil salinity. Many stakeholders believe that a country like Liberia with a humid climate and extensive rainforests cannot experience salinity-related conditions. Salinity can kill plants and other soil organisms and is referred to as a “silent killer” in some regions or as “white death” in others as it invokes images of a lifeless, shining land studded with dead trees. Research reports indicate that all natural water contains soluble salts. When this natural water is used on agricultural land, the salt builds up over time. Eventually, this accumulation can become hazardous to crop growth and development, leading to reduced yield and performance.

This case becomes a concern when an excess amount of concentration of soluble salts occurs in the soil, either by a natural or as a result of mismanaged irrigation water. Salinity could be one of the causes for low crop productivity in various areas in in Liberia. Tangible research to investigate the

level and distribution of salinity given the fact that Liberia as a costal country became a reality whe the RESADE project was launched in Liberia on July 1, 2019 at the Central Agriculture research Institute (CARI), which was then followed by the testing of salt tolerant crops accompanied by agricultural best practices to improve food security and increase farmers incomes in areas affected by salinity in Liberia. . Saltwater intrusion, particularly in coastal areas, is one of the main contributors to soil salinity. The rise in sea levels, driven by climate change, exacerbates this problem by allowing saltwater to penetrate freshwater aquifers and soils. A repetition of such occurrence would always leave some significant amount of soluble salt in the underground water which might reach the soil surface during capillary rise. This calls for an early warning as Liberia with such ecology might encounter severe salinity in the near future especially when farming practices increase and the level of irrigation water used is increased.

3.0 Factors that may impact Soil Salinity in Liberia

3.1 Climate Change and Sea-Level Rise

The global rise in sea levels is predicted to increase by 1 to 2 meters by 2100 and could result in higher rates of saltwater intrusion in Liberia's coastal zone. The salinization of agricultural land may spread further inland, negatively affecting soil quality and crop yields.

Liberia's vulnerability to extreme weather events, such as heavy rainfall and floods, may also contribute to the movement of salts across previously unaffected areas, further intensifying the soil salinity problem.

3.2 Expansion of Irrigated Agriculture

As Liberia's agricultural sector grows, more irrigation systems are being developed to increase crop yields, especially in areas where rainfall is irregular or insufficient. However, if irrigation is not managed effectively, it can contribute to increased soil salinity due to waterlogging and salt buildup in the soil.

The challenge lies in ensuring that modern irrigation techniques, such as drip or sprinkler systems, are implemented alongside proper drainage to avoid exacerbating the salinity problem.

3.3 Land Use and Agricultural Practices

In some parts of Liberia, traditional agricultural practices may lead to the accumulation of salts in the soil over time. Unsustainable farming techniques, such as overuse of chemical fertilizers, mono-cropping, and lack of crop rotation, can degrade soil health and contribute to salinization.

The expansion of cash crop cultivation (such as rubber and oil palm plantations) may also place pressure on fragile coastal soils, making them more vulnerable to salinization.

3.4 Government Policies and Agricultural Development

The future of soil salinity in Liberia will depend significantly on the country's approach to land and water resource management. Improved infrastructure for irrigation and drainage systems, along

with training for farmers on sustainable agricultural practices, could help mitigate the impacts of soil salinity.

Liberia's agricultural policies will need to focus on addressing soil health through research, education, and the adoption of new farming technologies that promote sustainability.

4.0 Potential Solutions and Mitigation Strategies for soil salinity in Liberia

4.1 Research and Monitoring

A comprehensive national soil salinity monitoring program is essential to track the extent of salinization across Liberia. This could include satellite imagery, soil testing, and on-the-ground surveys to assess salinity levels.

Research institutions in Liberia could collaborate with international partners to develop salt-tolerant crops and improve soil management practices suited to the country's unique soil and climatic conditions.

4.2 Sustainable Irrigation Practices

Encouraging the use of water-efficient irrigation systems, such as drip irrigation, can help reduce waterlogging and salinity. Effective drainage systems should also be integrated into irrigation projects to prevent salt buildup.

Promoting rainwater harvesting and the use of treated wastewater for irrigation could also reduce reliance on groundwater and decrease salinization risk.

4.3 Soil Amendments and Agroforestry

The application of soil amendments such as gypsum, organic matter, or biochar can help reduce salinity levels and improve soil fertility. Agroforestry techniques, such as planting salt-tolerant tree species along coastal zones, can also help improve soil quality and reduce saltwater intrusion.

Crop rotation and the use of salt-tolerant crops can help farmers adapt to saline soils, maintaining productivity despite salinity issues.

4.4 Climate Change Adaptation Strategies

Given the anticipated impacts of climate change, including rising sea levels, Liberia must prioritize coastal zone management to prevent further saltwater intrusion. This may include the construction of dikes and levees, as well as the restoration of natural coastal ecosystems such as mangroves, which act as buffers against seawater intrusion.

Liberia's farmers can also benefit from climate-smart agriculture, which includes adaptive farming techniques such as climate-resilient and crop dicversification, and better forecasting to cope with the effects of unpredictable weather patterns.

4.5 Public Awareness and Education

Educating farmers and communities about the risks of soil salinity, the importance of proper irrigation and drainage, and the use of sustainable farming practices is essential.

Training programs can be developed in collaboration with agricultural extension services, universities, and NGOs to equip farmers with the knowledge and tools needed to manage salinity and improve soil health.

5.0 Efforts from Foreign Partners in solving the problem of Salinity in Liberia

The RESADE project was initiated in 2019 by the International Center for Biosaline Agriculture during the tenure of former Director General Dr. Marcus T. Jones, who played a key role in securing the project. At that time, Liberia had only one scientist specializing in salinity research, Dr. James S. Dolo. Since the project required the focal person to demonstrate expertise in salinity research, Dr. Dolo was recommended by the CARI administration to serve as the project national coordinator.

The introduction and implementation of the RESADE project in Liberia has provided an opportunity for many individuals to rethink their views on soil salinity in the country. The project was launched at the ICBA headquarters in Dubai and attended by representatives from seven countries in Sub-Saharan Africa who were qualified by ICBA to participate. The Director General and project focal person from CARI represented Liberia at the launch. Following the event in Dubai, an in-country meeting was held in Liberia from July 1 to July 7, 2019, to officially launch the project. After the launch, a review session for Water Resource Management Policies in Liberia was convened aimed at developing a comprehensive water resource management policy for Liberia.

At the request of the ICBA, a team was formed consisting of seven staff members from diverse professional backgrounds to implement the project. Utilizing a modeled salinity map developed by the ICBA, the RESADE-CARI team searched for saline soil or saline water in three counties of Liberia, Bomi, Montserrado, and Grand Bassa.

In Grand Bassa, specifically at compound #1, the search team identified a highly saline river with a water salinity level of 6.2 dS/m. This salinity level is severe enough to kill most crops or hinder their growth and development anywhere in the world. This discovery was crucial for the RESADE Team to initiate project activities in Liberia. The finding was reported to the ICBA, and in response, two experts were dispatched to Liberia to verify the report and provide the country team with the approval to commence the project.

The saline Mechlin River in Compound # 1, Grand Bassa County

The infrastructure for testing various salt-tolerant crops was then established, featuring a fully drip-irrigated system that utilized the saline water from the Mechlin River in Compound #1, specifically in the Plunkor community near Edina City. The RESADE-CARI team conducted several trials, including an evaluation of twelve introduced salinity-tolerant crops, crop management trials, rice trials, and soil amendment trials.

Irrigation system in Plunkor, Grand Bassa County

The results from these trials indicated that out of the twelve salinity-tolerant crops developed at the International Center for Biosaline Agriculture (ICBA) and introduced to Liberia, only three were selected for their best performance within our local ecology, which is characterized by heavy rainfall, flooding, and low soil temperatures. These selected crops included two varieties of sorghum, pearl millet, and cowpea. Each of these crops offers high nutritional value and various options for value addition.

Cowpea

Sorghum and Pearl millet

The RESADE project introduced not only new crops but also advanced post-harvest equipment and tools for land preparation. However, the most significant change for farmers has been the establishment of a Community Seed Bank (CSB) in Grand Bassa County. This initiative provides farmers in various communities with sustainable access to quality seeds. Previously, farmers faced challenges in obtaining quality seeds, which hindered their production and overall productivity. This limitation impacted their ability to improve their livelihoods and adequately support their families. With the CSB, farmers can now access high-quality seeds with little or no financial cost, reducing transportation expenses from Grand Bassa to Monrovia. As a result, crop productivity is expected to improve immensely, and farmers can now increase their income/livelihood.

Some equipment provided by the project (RESADE)

Community Seed Bank established by RESADE

RESADE Farmers producing biochar **RESADE- Supervised Student project**

6.0 Conclusion

The disocovery of soil salinity in Liberia indicates a significant challenge, particularly for coastal farming regions. However, with proactive measures, including better irrigation management, government policies that promote sustainable agricultural practices, and investment in research, Liberia can mitigate the risks associated with salinization. The key will be a coordinated effort involving government agencies, agricultural stakeholders, and local communities to adopt climate-smart and soil-health-focused practices that will ensure long-term food security and economic stability for the country.

Previous Project Steering Committee Member, Liberia (2019-2020)

No.	Name	Current position in government	Position on Project Steering Committee	Email address
1	Ms. Paulette Findley	Officer-In-Charge/CARI	Member	pfindley1030@gmail.com
2	Hon. Precious K. Tetteh	Acting Minister (MOA)	Member	ptetteh@moa.gov.lr

Previous Project Implementation Unit (PIU), Liberia (2019-2021)

No	Name	Academic Qualification	Area of specialization	Responsibility	Sex
1	James S. Dolo	PhD	Agronomy/Plant breeding	Coordinator	**M**
2.	David S. Kolleh	MSc	Agronomy	Agronomist	M
3.	Prince Hiamah	MSc.	Soil Science	Soil/water specialist	M
4	Nataline S. Baysah	MSc.	Seed science and Technology	Post-harvest specialist	F
5	Sando Johnson	MSc	Irrigation engineer	Irrigation specialist	M
6	Mac-Arthur Paul	BSc. & PGD.	Economics & Procurement	Procurement specialist	M
7	Mercy Lah	MSc	Extension	FFSE facilitator	F
8	Jacob Kolleh	MSc.	Agriculture Economics	Local soci-economist	M

Current Project Steering Committee Member, Liberia (March 2024-present)

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4	Mac-Arthur Paul	BSc. & PGD.	Economics & Procurement	Procurement specialist	M
5	Mercy Lah	MSc	Extension	FFSE facilitator	F
6	Eric Pluato **(Joined 2024)**	MSc.	Agriculture Economics	Local soci-economist	M
7	Mark newah	BSc	Communication	Communication specialist	M
8	Martin Yarkpawolo	BSc	General Agriculture	Technician	M
9	Zokungay Mehn	BSC	General Agriculture	Technician	M