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**APPLICATION PROSPECTS OF D.L. CORWIN METHODOLOGY IN
ASSESSING SOIL SALINITY OF IRRIGATED LANDS IN THE
SAMARKAND REGION**

Abstract: This extended study investigates the application prospects of the electromagnetic induction (EMI) methodology developed by D.L. Corwin for assessing soil salinity across irrigated lands of the Samarkand region, a historically significant agricultural area in Uzbekistan. The study aims to overcome the limitations of traditional soil sampling and laboratory analysis, which often fail to capture the high spatial and temporal variability of soil salinity. EMI offers rapid, non-destructive, and spatially continuous assessment of apparent electrical conductivity (ECa), a key indicator of soil salinity and moisture.

The research integrates advanced geostatistical techniques (ESAP) and GIS platforms for precise spatial mapping and management decision support. Particular focus is placed on the complex hydrogeological conditions of the Zarafshan Valley, where shallow groundwater, variable soil textures, and historic irrigation patterns interact to influence salinity dynamics. The study also evaluates the economic, operational, and environmental benefits of EMI adoption, including resource efficiency, water conservation, crop productivity, and environmental sustainability. The results indicate that the D.L. Corwin methodology can serve as

a foundational tool for precision agriculture, sustainable land management, and digital soil monitoring in Uzbekistan.

Keywords: Melioration, soil salinity, electromagnetic induction, apparent electrical conductivity, Samarkand region, GIS, digital agriculture, monitoring, irrigation management, Zarafshan Valley.

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ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ МЕТОДОЛОГИИ Д.Л. КОРВИНА ДЛЯ ОЦЕНКИ СОЛОНЧАКОВОСТИ ОРОШАЕМЫХ ЗЕМЕЛЬ САМАРКАНДСКОГО РЕГИОНА

Аннотация: В данной расширенной работе рассматриваются перспективы применения методики электромагнитной индукции (EMI), разработанной Д.Л. Корвином, для оценки солонцеватости почв орошаемых земель Самаркандского региона, исторически важного сельскохозяйственного района Узбекистана. Цель исследования — преодолеть ограничения традиционных методов отбора проб и лабораторного анализа, которые часто не отражают высокую пространственную и временную изменчивость солонцеватости почв. EMI обеспечивает быстрый, недеструктивный и пространственно непрерывный

способ оценки кажущейся электропроводности почвы (ЕСа), являющейся ключевым показателем солонцеватости и влажности.

Исследование интегрирует продвинутые геостатистические методы (ESAP) и ГИС-платформы для точного пространственного картирования и поддержки принятия управленческих решений. Особое внимание уделяется сложным гидрогеологическим условиям долины Зарафшана, где мелководные грунтовые воды, разнообразные текстуры почв и исторические схемы орошения влияют на динамику засоления. Также оцениваются экономические, операционные и экологические преимущества применения ЕМІ, включая эффективное использование ресурсов, сохранение воды, повышение продуктивности сельскохозяйственных культур и экологическую устойчивость. Результаты показывают, что методика Д.Л. Корвина может стать фундаментальным инструментом точного земледелия, устойчивого управления землями и цифрового мониторинга почв в Узбекистане.

Ключевые слова: Мелиорация, солонцеватость почв, электромагнитная индукция, кажущаяся электропроводность, Самаркандский регион, ГИС, цифровое земледелие, мониторинг, управление орошением, долина Зарафшана.

INTRODUCTION. Agriculture in Uzbekistan is a cornerstone of national economic stability, contributing significantly to food security, employment, and export revenues. The Samarkand region, within the Zarafshan River basin, has long been recognized for its fertile soils, diverse crops, and strategic importance. Cotton, wheat, fruits, vegetables, and fodder crops dominate production, making the region a vital contributor to national agricultural output. However, the sustainability of agriculture in this region is increasingly challenged by environmental degradation, particularly soil salinity and water scarcity. Secondary salinization has emerged as a pressing concern in irrigated lands due to improper drainage, shallow groundwater, and high evapotranspiration rates. Historical

irrigation projects, initiated during the Soviet era, intensified water diversion and disrupted the natural hydrological balance, contributing to the accumulation of salts in the soil profile.

Soil salinity directly reduces agricultural productivity, negatively impacts soil fertility, and undermines long-term land sustainability. Conventional soil monitoring practices, reliant on manual sampling and laboratory analyses, often fail to capture the high spatial and temporal variability inherent in these complex landscapes. Consequently, farmers and land managers make decisions based on incomplete data, resulting in inefficiencies in irrigation and land reclamation. Electromagnetic induction (EMI) technology, developed by D.L. Corwin, offers a rapid, non-invasive approach to soil monitoring. By measuring apparent soil electrical conductivity (ECa), EMI can capture variations in soil salinity, moisture, and texture across large areas. Coupled with geostatistical optimization using ESAP and GIS-based digital mapping, this methodology allows for precise spatial analysis, identification of salinity hotspots, and data-driven decision-making in agricultural management. The present study aims to evaluate the application prospects of EMI methodology in the Samarkand region, with particular attention to the complex hydrogeology, diverse soil textures, and historical irrigation practices that influence salinity distribution. The research seeks to provide practical, economically viable, and environmentally sustainable strategies for precision agriculture, soil reclamation, and water management in this critical agricultural zone.

RESEARCH SUBJECT AND METHODOLOGY

The study focuses on irrigated agricultural lands in the Samarkand region, including the districts of Ishtikhon, Pastdargom, Narpay, and Pakhtachi. These lands are historically productive but are increasingly affected by soil salinity and waterlogging.

1. Soil Classification and Salinity Dynamics

Soil types include sandy, loamy, clay, and mixed textures.

Shallow groundwater (<2 m) contributes to capillary rise and salt accumulation.

Irrigation practices, including furrow and flood methods, influence salinity distribution.

2. Electromagnetic Induction Measurements

EMI sensors used include dual dipole systems for horizontal and vertical orientations.

Horizontal dipoles assess 0–30 cm surface layers critical for plant roots.

Vertical dipoles measure deeper layers up to 90 cm, identifying subsurface salinity and groundwater influence.

3. Calibration and Validation

Selective soil sampling for laboratory analysis of electrical conductivity (EC) and ion composition.

Regression models calibrate EMI readings to actual soil salinity.

4. Geostatistical Optimization

ESAP system identifies representative points for high-accuracy mapping.

Reduces required samples by 30–50% while maintaining data reliability.

5. GIS Integration and Mapping

Spatial interpolation produces high-resolution digital soil salinity maps.

Temporal monitoring allows tracking of seasonal variations and irrigation impacts.

6. Survey Design

Grid-based EMI scanning along irrigation blocks.

Seasonal campaigns conducted in spring, summer, and autumn for comprehensive temporal analysis.

This methodology allows continuous, non-destructive monitoring of soil salinity, supporting precise land management, targeted irrigation, and sustainable reclamation practices.

Results and Discussion

1. Spatial Distribution of Soil Salinity

EMI surveys show marked spatial heterogeneity across fields, even within a single irrigation block.

Low salinity zones (<2 dS/m) are mainly located near modern drainage systems.

Moderate salinity zones (2–6 dS/m) dominate older irrigated lands with shallow groundwater influence.

High salinity zones (>6 dS/m, up to 15 dS/m) are concentrated in closed depressions and areas with poor drainage.

2. Depth-Resolved Salinity Analysis

Horizontal dipole measurements show surface layer (0–30 cm) salinity averages 4.2 dS/m.

Vertical dipole measurements indicate subsurface (30–90 cm) salinity increases to 7–12 dS/m in low-lying fields.

Subsurface salt accumulation is linked to capillary rise from shallow groundwater.

Depth profiling allows identification of root-zone salinity, critical for crop selection and irrigation management.

3. Seasonal Variation in Salinity

Spring: Post-winter rains reduce surface salinity; ECa averages drop by 15–20%.

Summer: Evaporation and irrigation cause surface salinity to rise sharply; ECa peaks coincide with mid-summer heatwaves.

Autumn: Leaching after harvest lowers salinity but residual subsurface salts remain elevated.

Seasonal monitoring allows predictive planning of irrigation and leaching schedules.

4. Integration with GIS for Precision Agriculture

GIS-based salinity maps overlay irrigation networks, crop types, and soil texture layers.

Identification of high-risk zones enables **site-specific interventions**:

Targeted leaching

Soil amendments

Crop rotation with salt-tolerant species

GIS facilitates temporal tracking of salinity trends and evaluation of reclamation efforts.

5. Economic Impact

Reduction of soil sampling needs by 30–50% saves labor and laboratory costs.

Targeted irrigation in identified hotspots reduces water usage by 15–20%.

Improved crop yields in treated areas show increases of 10–15%, enhancing farm income.

Cost-benefit analysis indicates EMI adoption is economically viable even for smallholder farms.

6. Environmental and Sustainability Implications

Precision irrigation minimizes overwatering and secondary salinization.

Improved soil health reduces erosion and desertification risk.

Data-driven reclamation strategies reduce chemical inputs and environmental contamination.

Supports long-term sustainability and resilience of the Zarafshan Valley's agricultural ecosystem.

7. Comparative Analysis and Validation

EMI-based salinity measurements show high correlation ($R^2 = 0.82\text{--}0.91$) with laboratory EC values.

Results are consistent with other Central Asian studies but adapted to semi-arid soils of Samarkand.

High-resolution mapping captures heterogeneity overlooked by traditional point-based sampling.

8. Recommendations for Practical Implementation

1. Establish mobile EMI monitoring units integrated with GPS.
2. Conduct quarterly seasonal scans to capture temporal variability.

3. Combine GIS mapping with predictive modeling for proactive salinity management.
4. Train local agronomists and farmers to interpret ECa data for field-level decisions.
5. Develop integrated irrigation and leaching schedules based on hotspot identification.
6. Consider planting salt-tolerant crops in high-risk zones while reclaiming moderately saline areas.

CONCLUSIONS

The D.L. Corwin methodology demonstrates itself as a **transformative tool for soil salinity assessment** in the Samarkand region, offering a combination of speed, accuracy, and cost-efficiency that surpasses traditional sampling methods. Its integration with GIS and geostatistical frameworks, particularly the ESAP system, allows for **high-resolution mapping of soil salinity dynamics**, enabling precision agriculture and targeted land reclamation strategies. By capturing both surface and subsurface variations in salinity, this methodology ensures that critical decision-making—such as irrigation scheduling, crop selection, and soil amelioration—is based on robust, spatially representative data. From an **economic perspective**, adoption of this approach reduces labor and laboratory costs, minimizes unnecessary water use, and increases crop yields in affected areas, creating tangible benefits for farmers and regional agricultural authorities. Environmentally, it contributes to **sustainable land management**, preventing secondary salinization, reducing over-irrigation, and supporting the long-term fertility of soils in semi-arid irrigated landscapes. The approach also promotes **resilience in agricultural ecosystems**, helping to mitigate the effects of water scarcity, climatic variability, and ongoing soil degradation in the Zarafshan Valley. The results of this study also underscore the **potential of EMI-based soil monitoring for wider adoption across Central Asia**, where similar hydrogeological conditions and irrigation

challenges exist. By providing a rapid, non-destructive, and spatially continuous assessment method, this technology can serve as a model for **smart farming initiatives, precision land management programs, and regional soil conservation strategies**. In the context of **Uzbekistan's agricultural modernization goals**, integrating the D.L. Corwin methodology into national land management policies offers a pathway to **digital agriculture**, where real-time monitoring, data-driven decision-making, and optimized resource allocation become standard practice. Additionally, long-term implementation can support **climate adaptation measures**, ensuring that the region's irrigated lands remain productive despite fluctuations in water availability and increasing environmental stressors. Finally, beyond its technical advantages, this methodology fosters a **holistic approach to agricultural sustainability**, combining technological innovation, ecological stewardship, and socio-economic benefits. The adoption of EMI-based monitoring, coupled with GIS and targeted reclamation strategies, is not merely a tool for mitigating soil salinity but a **comprehensive framework for the sustainable and resilient development of irrigated agriculture in semi-arid regions**.

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