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Progress Report: Assessment of Groundwater Resources in the Southern Coastal Water Province of Belize Referred to as Savannah Groundwater Province

Contracted by:

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Introduction:

This progress report is presented to inform the contractor **United Nations Development Programme (UNDP)** and **National Integrated Water Resource Authority (NIWRA)** about the status of conducting an Assessment of Groundwater Resources in the Southern Coastal Water Province referred to as the Savannah province.

Data acquisition:

GEOMEDIA requested a number of governmental and private departments and agencies for their support in terms of providing relevant data on geology, hydrology, hydrogeology.

NIWRA issued the letter requesting the release of data from relevant ministries and letter of support for GEOMEDIA that considerably facilitated the communication with key authorities in Belize.

Up to date, many relevant data and information were collected, notably from Hydrology Unit (National Meteorological Service), Ministry of Health, Geology and Petroleum Department (Ministry of Energy, Science & Technology and Public Utilities), Department of the Environment (Ministry of Forestry, Fisheries and Sustainable Development), Public Utilities Commission, Belize Water Services Ltd., Ministry of Agriculture & Fisheries.

Water quality data

In total, over 700 records were collected in the frame of the Groundwater Assessment Project concerning water chemistry data, water well log reports, groundwater yield (see Tab. 1).

These datasets include water well logs containing also information about well depth, diameter, water static level, shallow geology etc. Further hydrochemical data were collected for groundwater and surface water, whereby groundwater data prevail. All chemical values were compared to drinking water standard limits.

Tab. 1: List of processed hydrochemical data in Savannah Groundwater Province, Belize.

Data Source	Data description	Data Amount
GEOMEDIA	Places visited during field work	167 samples
GEOMEDIA	Water sampling during field work	113 samples
GEOMEDIA	Detailed chemical data for 13 wells	13 samples
Ministry of Rural Development	All information about water well log reports for Stan Creek District	49 samples
Ministry of Rural Development	All information about water well log reports for Toledo District	19 samples
Public Utilities Commission	Wells chemical data	7 samples
Ministry of Health	Groundwater and surface water chemical data	90 samples
Ministry of Health	Chemical data for wells in Savannah Groundwater Province	10 samples
Belize Aquaculture Limited	Chemical data for 5 wells (along time)	77 records
Belize Aquaculture Limited	Chemical data for one documentation point in time	11 records
Belize Water Service Limited	Chemical data for 2 wells	2 samples
Public Health Bureau (The Ministry of Health)	Chemical data for 3 wells in Stan Creek District	3 samples
GEOMEDIA/banana farms	Chemical data for banana farms	17/108 samples
Public Utilities Commission	Yield values for Savannah Groundwater Province	16 records
Total		702 records

Hydrogeological and geophysical data

Relatively extensive data sets on climate (rainfall, evapotranspiration, temperature), hydrology (river flow rate), geology, land use (land cover) were acquired.

River flow rate data acquired:

Data Source	Data description	Data Amount
Hydrology Department	Stream flow for Sittee River (19 years)	6 935 records
Hydrology Department	Stream flow for Monkey River, at Swasey bridge (21 years)	7 665 records
Hydrology Department	Stream flow for Monkey River, at Bladen bridge (21 years)	7 665 records

Pumping test data were collected in a limited extent.

Geophysical well-logs from 4 deep oil & gas exploration boreholes (San Juan 1, 2, 3, Monkey River) in the overall length of over 3,100 m were acquired and subsequently analyzed.

Field work

Field work was carried out between January 19, 2014 and February 14, 2014. Entire area of the Savannah Groundwater Province was investigated as documented in fig. 1 (below).

In the first step of field work main activities were focused on mapping and verifying known hydrogeological objects (mainly existing wells). Mesh of these objects formed basic information database of study area. Next step was dedicated to filling up basic information database by exploring areas with low or lack of data about hydrogeology.

Attention was paid not only to existing wells/boreholes but also to other natural and geological phenomena relevant to hydrogeological conditions in area (i.e. surface water bodies, rock outcrops, etc.). During the field work, 167 sites in total were documented in the entire Savannah Province (see Fig.1) from that 113 documentation points were identified as groundwater or surface water objects. The remaining sites are rock outcrops and sites with significance for geological structure or other.

Each of the sites was GPS localized and documented including photo documentation. In case of wells, information on depth of well, static/dynamic groundwater level and its fluctuation, average pumping rate, geology and archive chemical analysis were collected depending on availability of information or direct site measurement.

Ground/surface water from documented points was sampled and basic chemical indicators (pH, temperature, total dissolved solids TDS, dissolved oxygen DO, electroconductivity EC, turbidity) were analyzed by means of GPS AQUAMETER AM-200™ and AQUAPROBE AM-600™, brand SQUAREAD™.

113 water objects were analyzed directly in the field. 13 samples were additionally analyzed for other relevant chemical parameters in the laboratory of Bowen & Bowen, Ltd. (electroconductivity EC, pH, total dissolved solids TDS, turbidity, Ca, Cu, Al, Fe, Mn, Mg, Na, F, HCO₃, NH₄, CO₃, Cl, hardness, alkalinity, NO₃, NO₂, PO, salinity, NaCl, SO₄).

The field work contributed to re-assessment of boundary conditions of Savannah Groundwater Province. As a result, the limits of the Savannah Province were adjusted and the current area reaches 2,040 km².

Data management and synthesis

Follow-up activities are dedicated to assessment of the collected data and information and to preparation of conceptual model of Savannah province. This phase of office work is currently in progress.

Data processing by means of GIS and data assessment activities follow three directions:

- Analysis of natural conditions throughout the whole Savannah province area including the evaluation of climatic data (rainfall, evapotranspiration, temperature), hydrological data

(rivers flow rate), data on land use (land cover) and its interactions. This analysis is necessary for quantifying the natural water cycle in the investigated area.

- Analysis of groundwater and surface water chemistry including existing collected chemical data and field data measured during the project. The analysis and chemical data processing should reflect the spatial distribution of sampled sites or if available the time series enabling the interpretation of local hydrochemical stability. Results of this analysis facilitate the identification of separate zones characterized by different hydrogeological conditions and regime.
- Analysis of regional hydrogeological structure, geology and physical properties of rock formations. This analysis and synthesis includes definition of regional geology structures, occurrence of aquifers and aquitards, their geometry, evaluation of pumping tests, estimation of hydraulic conductivity of hydrogeological formations, their spatial distribution and interpretation of groundwater levels throughout the Savannah Province.

Conclusion and further plans:

The first part of the Groundwater Assessment Project in the Savannah Province was dedicated to collecting of information and data relevant for the groundwater assessment.

Existing data were supplemented by measured data and observation in field. The stage of field work, carried out between January 19, 2014 and February 14, 2014, represented the crucial part of the Project. The field work was successful as it included the overall assessment of the investigated area in terms of geomorphology, geology as well as qualitative and quantitative characterization of water resources and thus considerably contributed to the current characterization of the Savannah Groundwater Province.

Based on the interpretation of available borehole data, including available pump test data as well as deep well-logs, the drilling plan is set for 2 groundwater wells to the depth of 150 m maximum, contributing to the knowledge of upper freshwater aquifer. These wells are due to be drilled in May, 2014 under supervision of GEOMEDIA.

The data are currently in processing with emphasis to the identification of complex relationships and interactions of various components of geo-hydrological environment by means of GIS database as well as numerical modeling.

The field work observation enabled the re-assessment of Savannah Province boundary and general definition of the conceptual model. The conceptual model is currently being developed in detail and implemented in mathematical modeling software tools.

Further steps of the project include detailed data processing with emphasis to measured chemical parameters and development of reliable mathematical model reflecting the hydrogeological structure of the Savannah Province and enabling various development scenarios simulation.

GEOMEDIA will elaborate the First Technical Report including all relevant results and findings up to date including map annexes by April 30, 2014.

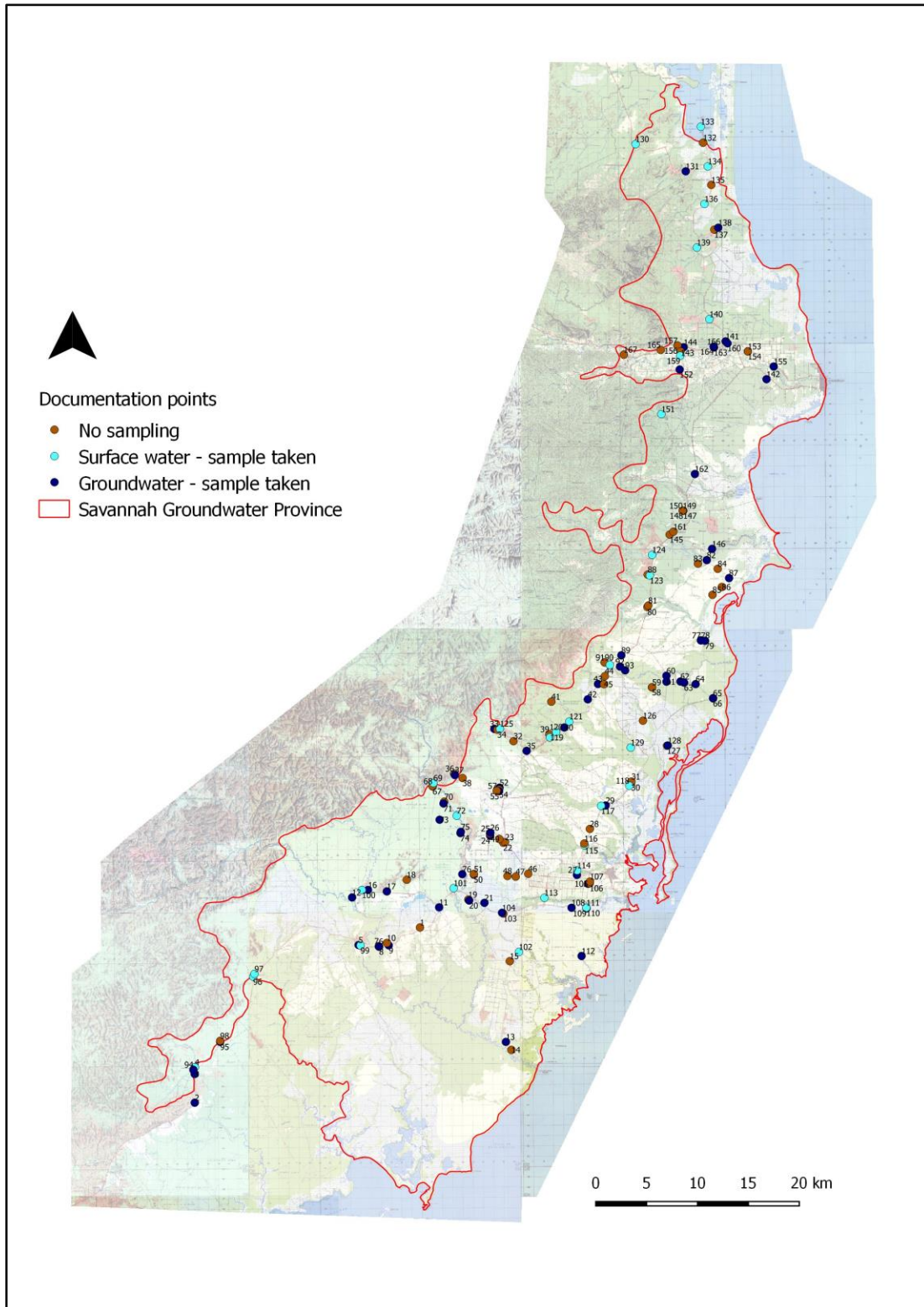


Fig. 1 Visited investigated sites during field work.