ID#759

GIS Analysis Methodology for Unconventional Resources Field Optimization

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Abstract

Unconventional hydrocarbon extraction technologies and processes are new, it involves certain risks and needs to consider health, environment, and safety of people, economic and geological aspects. Unconventional Resources field development for gas and oil occupies a large surface area that requires surface facilitation structure and organization. The surface areas involve different land use types and facilities that involves multiple criteria analysis to support decision making.

GIS with its spatial analysis technique provide computational models within or outside of GIS framework. Its integration with other technology to manage spatial data and its related information which will help in planning to conduct field analysis and development. In this study, GIS computation models and integration capabilities are utilized to assess and develop various algorithm models to support unconventional surface well pad locations (Figures 1,2).

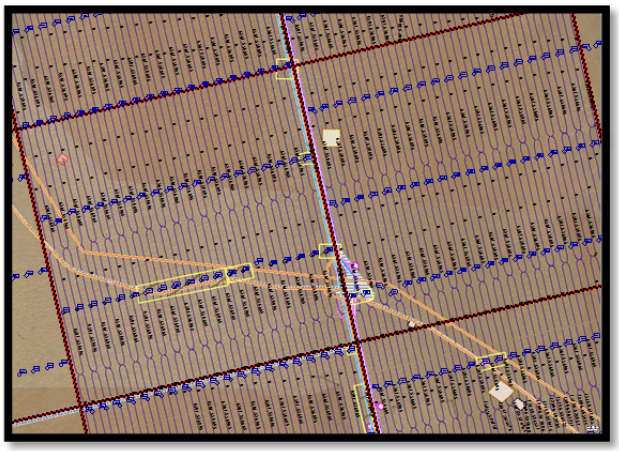

Figure (1) Surface Facility

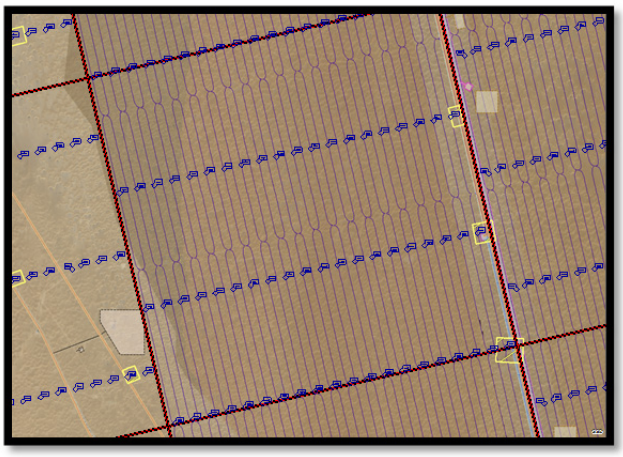

Figure (2) Well Pads

Extended Abstract

Objective

Unconventional reservoirs are typically defined as hydrocarbon resources with low permeability that cannot be economically produced without stimulation.

Unconventional Resources occupies a large surface area that requires facilitation and organization. Planning of sustainable environment for development of unconventional resources is a challenging task for the many involved which requires optimal use of available knowledge for decision support. (Ahmed, 2016)

Economic and safety Impact of Unconventional Development and Production

As unconventional development is much more costly than conventional may play a significant role in economics, exploring all possible scenarios in field development is particularly crucial for safe and profitable exploration and production.

Unconventional require hundreds of accurately placed well over a large surface area to produce effectively. Unconventional resources have much shorter well lives, making it critical for teams to optimize their producing time and apply learnings to future wells. If production areas are located in densely populated areas then it requires an extensive study to ensure maximum optimization of production. It requires feasible development plan to avoid compensation, implement safety standards and maintain optimum production. A real time to analyse man made surface facilities, measuring and optimizing assets, effective well trajectories with collaborative tools for modelling will help to manage all and optimize well production. Ability to incorporate for GIS (Geographic Information System) will help in planning, managing UR well placement optimization and support management decisions. (Aerts, 2003)

Conventional resources and unconventional resources are two very different, separate sets of resources that can potentially be extracted. Both refer to some quantity of fossil fuels that could contribute to a reserve if they could be extracted economically. The distinction between a resource and reserve is explored; The difference between conventional and unconventional is relatively straightforward, and has to do mostly with the ease the fuels can be extracted.

Conventional oil or gas comes from formations that are "normal" or straightforward to extract product from. Extracting fossil fuels from these geological formations can be done with standard methods that can be used to economically remove the fuel

from the deposit. Conventional resources tend to be easier and less expensive to produce simply because they require no specialized technologies and can utilize common methods. Because of this simplicity and relative cheapness, conventional oil and gas are generally some of the first targets of industry activity.

Unconventional Oil Resources

Figure (3) Bitumen soaked sandstone.

Figure (4) Oil shale.

In contrast to this, unconventional oil or gas resources are much more difficult to extract. Some of these resources are trapped in reservoirs with poor permeability and porosity, meaning that it is extremely difficult or impossible for oil or natural gas to flow through the pores and into a standard well. To be able to produce from these difficult reservoirs, specialized techniques and tools are used. For example, the extraction of shale oil, tight gas, and shale gas must include a hydraulic fracturing step in order to create cracks for the oil or gas to flow through. In the oil sands, in situ deposits must utilize steam assisted gravity drainage to be able to extract thick bitumen from underground deposits. All of these methods are costlier than those used to produce fossil fuels from a traditional reservoir, but this stimulation allows for the production of oil and gas from resources that were previously not economic to extract from. These resources become reserves when they can be utilized economically.

Unconventional resources are being utilized more and more as decades of oil and natural gas production have resulted in extensive use of conventional resources. Because of this, new technologies are constantly being introduced that allows for the more economic extraction of non-traditional oil and gas that may have been

previously impossible to obtain. Development of these unconventional resources has significant economic potential as a large portion of oil and gas resources is estimated to exist in unconventional deposits. For example, in Canada, estimates put oil reserves at 174 billion barrels of oil, with 169 billion being in the oil sands - a type of unconventional resource. Similarly, there is far more natural gas in unconventional deposits rather than conventional ones (Figures 3,4).

Integration of UR and GIS

Spatial information is very important at every stage of development, from exploration to production. Hence integration of databases and tools into GIS would immensely support in taking decisions considering safety as well as economical aspect. Pipelines, powerlines, offices and other facilities are all geographically dispersed are all part spatial analysis. Tools, models and maps not only help in running different algorithms but also help in visualizing the results for better decision making.

Using GIS technology modelling for well planning placement and surface facilities design to develop alternate scenarios along with their full-field well plans, ensuring that every possible scenario is considered before drilling.

The GIS technology helps team's plot all development blocks attributes and look for diagnostic factor the drive well pad placement and production based on custom criteria. This help teams to focus on the most productive well and reducing non-productive time. (Matias, 2012)

Planning and designing of this infrastructure require incorporation of both temporal and spatial aspects, in this study a toolbox has been developed that integrates ArcGIS, a geographical information system with spatial and routing functions.

Development of ArcGIS Models and tools

Geospatial tools have been utilized in various industries and its capabilities have been utilized in various practices. The Unconventional fields show a unique use of Geospatial algorithms that can be expanded on in revolutionizing computer-based problem solving.

The unconventional resources focused at the development of GIS model. The GIS model was largely based on the Land-Use Conflict Identification Strategy (LUCIS) model to highlight the impact on oil and gas field development.

Firstly, accessibility analysis map was created of all proposed well pad, surface facilities with respect to land use model. The accessibility analysis map was used as weighting to the goals and preference maps. The Analytical Process was used as weighting methods using ArcGIS spatial analysis function to give the model shape in GIS.

Utilizing Geospatial tools assistance in generating detailed maps, a streamlined surface assessment process can be made to minimize surface conflicts with outside public and private entities, highlighting existing conflicts that may affect future projects.

Surface accessibility studies can be generated to highlight areas with varying accessibility for development, Geospatial tools are crucial in managing future projects and the first step in studying the feasibility of new potential locations. The review of arising conflicts by outside entities to protect the integrity of UR facilities is made efficient. This enables a swift execution of facility planning and enables an accurate estimation of project estimation.

Using GIS spatial analyst tools, enables unconventional project organizations to perform land, drilling subsurface and site visit crows to plan field developments which will streamline operations activities and evaluate reserve areas to lead the forecast volumes during production.

By using GIS spatial analyst tool, you can dramatically cut complex, time-consuming and data intensive well planning and reserve area evaluation workflows:

- Identify allowable areas for operations by creating setbacks from access, land use and environmental factors.
- Manage sub-surface constraints to positioning well bores at depth in relation to the surface facilities land use.
- Evaluate land use site locations relative to the existing and future oil & gas surface operation facilities.
- Assist Exploration Department to create development wells also, plan strategy for development and appraisal wells against future and existing land use.
- Assess how many well pads can be placed throughout your area of interest in respect to land use.
- Calculate lateral spacing length between surface and subsurface wells layers.
- Generate RER buffer to identify populated area that might be affected by H_2S.
- Identify the most efficient well development plan, placing pads and laterals so that you minimize surface footprint while maximizing lateral lengths.
- Forecast reserve addition through time.

Methods

The initial process in planning and integration initiated by subsurface team (Reservoir) and guidelines received is the first step in development of a plan for GIS data analysis and manipulation for surface facilities. Depending on subsurface team the field reservoir development limit has been defined as series of blocks, each of blocks identified by block name, number and development year for each block. The landscape is analysed for various land use types that includes farms, industries, populated areas or existing infrastructure and facilities.

Classification of the existing data and applying relevant standards is key to unconventional hydrocarbon development of oil and gas fields. The spatial and non-spatial data required for building tools and customizations are collected, created and managed through various sources. These datasets are either vector or raster data (Aerial and Satellite Imagery).

We have used GIS technology to create surface facilities model for vector data containing existing features such as transportation, pipeline, plants, powerlines and future facilities project and applied the safety standards and required parameters, spatial decision is designed to support the design and evaluation of allocation plans using optimization techniques.

Spatial analysis models involving geographic and non-geographic data for surface facilities were built to assess potential well pad placement on the surface area to avoid conflict with existing and planned infrastructure development.

Optimizing well pad and well lateral configuration is dramatically cut complex and time-consuming because we have to assess sub-surface drilling constrains, calculate lateral spacing, resolve well pad conflicts against surface right, future and existing surface facilities.

Potential conflicts in conjunction with safety regulations in terms of H_2S density and Rapture Exposure Radius are analysed. Various scenarios are run through to optimize well pad placement using GIS computational models to conduct field analysis. Spatial customized tools are developed for unaccounted parameters. The resultant data is overlapped on satellites imagery to validate data, measure land use property impact on unconventional development. Then estimate the number of well pad avail to determine infill potential and/or production analyses and also avoid rough terrain to the new well pad placement. (Broek, 2010)

Conclusions

- Utilizing Geospatial tools assistance in generating detailed maps highlighting potential conflicts.
- Streamlined surface assessment process can be made to minimize surface conflicts with public and private entities.
- Surface accessibility studies can be generated to highlight areas with varying accessibility for development.
- Geospatial tools are crucial in managing future projects and the first step in studying the feasibility of new potential locations.
- The review of arising conflicts by outside entities to protect the integrity of UR facilities is made efficient.
- This enables a swift execution of facility planning and enables an accurate estimation of project estimation.

2. Acknowledgments

Authors would like to express their appreciation to the URED management for their support and permission to publish this paper. Also, special thanks to our colleague for their support and stimulating discussions during the preparation of this paper.

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