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Case Report

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Principles In Practice: Impact Assessment For Wagon Creek Gas Field Activities At The Bonaparte Basin Of Australia

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Abstract
This paper critically and conceptually analyse the environmental impact of the Wagon Creek gas field activities at the Bonaparte Basin of Australia. The report would coherently discuss the potential impacts and review of the gas filed activities using the EIA principle and suggest mitigation actions which can bring success to the activities. Previous environmental impact assessment has shown that the natural gas plant gravely affected the natural environment profoundly, because of the natural gas spill and other related activities. This shows cumulative impacts will occur when the gas expansion project commences. The overview of potential impacts is shown in table 1 as analysed from the literature review of oil and gas projects from similar locations. The report can be useful to provide the necessary confidence to proponents, decision makers and the public about the broader context and long term environmental conditions more likely to result from the gas field activities.

Key Words: Basin, Environmental Impact Assessment, Natural Gas and Impact Mitigation.

Abbreviations
EIA: Environmental Impact Assessment, IOCs: International Oil Companies, MMScf: Million square cubic feet.

Introduction
The Bonaparte Basin is within one of the Australia's major offshore petroleum-bearing geologic provinces located in the northwestern part of the country. As the growth of the world population continues to increase, subsequently the demand for oil and gas continue to increase (EIA 2014). This has led IOCs to search for oil and gas in most potential regions of the world, to be able to meet the growing demand for world oil and gas consumption [1]. The EIA report for 2014 has estimated that the world oil consumption rate grew by 0.9million bbl/d in 2014, averaging 91.4million bbl/d for the year. One of the remote places where IOCs are currently exploring and producing natural gas is the Bonaparte Basin of Australia [1]. Over the last two centuries the emission of methane (CH4) gas into the atmosphere have been more than doubled hence the CH4 concentration increases rapidly. However, the target of the 21st century is to keep the increase of global warming less than 2oC. Meanwhile, all nations emphasized to the reduction of CO2 emissions but less action taken for CH4 emissions seriously.

According to (Anifowose 2015), Environmental impact is the adverse, beneficial, wholly or partial change to an environment resulting from a given organizational project. As a norm of exploiting natural resources such as natural gas from petroleum, activities such as exploitation, exploration, processing and distribution are an evitable events. Consideration of combined effects of all these project elements is generally considered as part of standard individual project. Hence, it is imperative to assess the combined effects of all elements of a single project on multiple environmental values (especially the flora and fauna) to take proactive measures which can mitigate the impacts of the project. This is starting from the initial engineering design stage to decommissioning (Anifowose et al. 2011)

Table 1: Environmental impacts from Bonaparte Basin due to project activities at the Waggon Creek gas field.

RECEPTORS	TYPES OF IMPACTS		
	Synergistic	Irreversible	Cumulative
LITHOSOHERE	The impact of speedy erosion as a result of land degradation due to project activities such as land clearing from the Wagon Creek field, Vienta field and along with possible urbanisation over time. (Chan 2010)	Continuous, rapid and complete destruction of vegetation cover as a result of the field development is an irreversible form of deforestation (Shukla et al. 1990)	Multiple wells development and eventually build of settlements over a time period could have cumulative impact leading to reduction of grassland ecosystem (Nasen et al. 2011)
BIOSPHERE	Over enrichment of the aquatic environment with nutrients because of leakage and discharge of impurities from the Wagon Creek gas field along with those from nearby field can lead to anoxic condition for aquatic life and growth of algal blooms (Carpenter 2005)	Excessive exposure to methane gas inhalation causes intestinal tract infection which could lead to death (Sahakian et al. 2010)	Decline in Biodiversity because of land clearing for the gas field development and other infrastructure (Isbell 2010)
ATMOSPHERE	Contamination of Methane and other greenhouse gases may have the potential to alter the Ozone layer thereby leading to global warming. (Scottish executive 2006)	An irreversible climatic change because of methane gas emission to the atmosphere. (Solomon 2009)	Cumulative emissions of potential greenhouse gases from the Wagon Creek gas field, Vienta gas field, foreseeable industrialisation and domestic use of energy could be a threat to global warming. (Xu and Lin 2015)

Potential emission of Methane gas at various stages of project activities at the Waggon Creek gas field has been determined as follows.

Production rate = 1.1 Million scf/day; Number of wells = 3000Wells
Production lifespan = 15-20 years
Methane gas percentage = 93.5%

A. Firstly, Considering an activity factor for just a year;
= 1.1 MMscf × 3000 × 1 × 365days
= 1204500MMscf/year

Percentage of Methane gas = 93.5% ×1204500MMscf
= 1126207.50MMscf/year

B. Potential Emissions at various stages of activities;

Production

Potential Emissions = ∑ Activity factor × Emission factor………Equation 1
[2].

Potential emission = 1126207.50 × 0.42%
= 4730.07MMscf/year
15years Potential emission = 4730.07MMscf × 15
= 70951.05MMscf/15years.
20years Potential emission= 4730.07MMscf × 20
= 94601.40MMscf/20years.

Processing:

Activity factor = 112607.50 – 4730.07
= 1121477.43 MMscf
Potential emission =1121477.43 MMscf × 0.19%
= 2130.81 MMscf/year
15years Potential emission = 2130.81MMscf × 15
= 31962.15MMscf/15years.
20years Potential emission= 2130.81MMscf × 20
= 42616.20MMscf/20years.

Transmission and storage:

Activity factor = 1126207.50 – (4730.07+ 2130.81)
= 1119346.62 MMscf
Potential emission = 1119346.62 × 0.44%
= 4925.13MMscf/year
15years Potential emission = 4925.13MMscf × 15
= 73876.95MMscf/15years.
20years Potential emission= 4925.13MMscf × 20
= 98502.60MMscf/20years.

Distribution:

Activity factor = 1126207.50 – (4730.07+ 2130.81 + 4925.13)
= 1114421.49 MMscf
Potential emission = 1114421.49 × 0.26%
= 2897.50 MMscf/year
15years Potential emission = 2897.50 MMscf × 15
= 43462.50MMsc/15years.
20years Potential emission= 2897.50 MMscf × 20
= 575950.00MMscf/20years.

Impact Analysis and Evaluation:

From the above estimates, it could be observed that the production stage has the highest emission potential followed by transmission and production, distribution and processing respectively. 3000 wells were considered for the activity factor to represent highest anticipated level of emission within the lifespan of the project. However, not only methane is emitted during gas production as study reports from Colorado confirms an elevated level of other volatile organic compounds such as Xylene and trimethylbenzene also emitted during gas production [3]. Meanwhile the constant emission factor has also been critiqued for reliability because of geographical variability and sampling [4]. Hence these are limitations for reliability and certainty. Using the EIA principles, impact analysis and mitigation of the Wagon Creek gas field activities has been evaluated as follows.

Production:

Extraction of the underground gas reserves represents the major activity at the production stage [5]. This is usually supported by the installation of facilities covering a large area of land mass. For example, it has been estimated that energy related activities as at 1975 accounted for 1.1 × 106 acres in the United State [6]. Considering this, gas production activities at the Bonaparte Basin with an estimated 3000 wells might have similar impact on total land area of Bonaparte Basin. Figure 1 shows the trend of deforestation in Australia within a period of ten years. Proposed that deterioration of resources leading to environmental degradation such as loss of biodiversity and deforestation were the common environmental impacts related to production activities [7]. Even though there are global commitments to reduce the loss of biodiversity, however strategic policies are in decline with accelerating threats [8]. Produced water in the cause of production which accounts for about 80% of residual waste from natural gas production may contaminate the Ord River used for irrigation [9]. Meanwhile 4730.07MMscf/year methane emission at the production state might be attributed to leakages from valves, compressors and other fittings during production [10]. On the other hand, the production activities of the field expected to bring about positive impact especially in areas of job creation [11]. However, as equal share of resources and justice becomes difficult in most parts of the world, usually conflict occurs between host communities over resources [12]. Based on this prospect, quoted that "Petroleum has always been a blessing and a curse" [13].

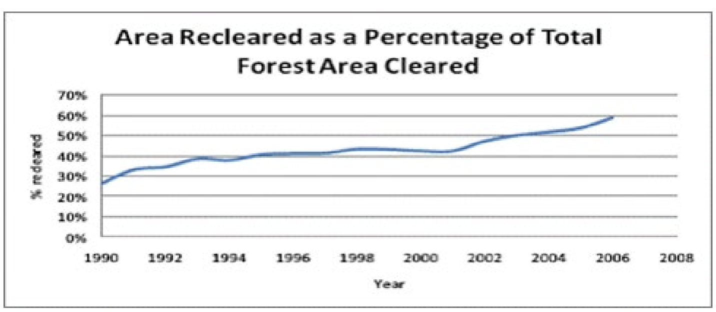

Figure 1: Percentage of forest area cleared within 10 years in Australia (Parliament of Australia 2008)

Mitigation:

To mitigate the impact on land use on the Bonaparte Basin, modern technology approach to multi-well pad otherwise called "Octopus" so far developed to reduce land surface area disturbance. However, among others have critiqued this technology due to elevated level of produced water generated. Hence there is need for produced water treatment strategy to adopt this technology [14, 15]. For methane emissions, expert's intervention is required to provide reliable data of emissions for increased effort to tackle leakages [16]. Moreover, production facilities should be on quarterly periodic check and maintenance as best control measure.

Processing:

Studies conducted by revealed that there are health implications such as skin cancer and other health indices associated with petroleum gas processing within the host environment [17]. However, sometimes over a long-term period such implications are not only on immediate environment but can reach beyond because of spatial nature of the atmosphere. Figure 2, shows a photograph of gas processing plant.

Figure 2: A gas processing plant [18].

Cumulative industrial actions of the Wagon Creek field and that from Vienta gas field can potentially cause noise pollution and intense rise in temperature due to sound and heat generated by engines and high-pressure burners among others [19]. Proved that non-auditory health effects were found as cause of industrial noise [20]. A survey of 108 individuals within 14 counties in Pennsylvania living near to gas facilities revealed absolute similarity of self-reported health effects [21]. Although, health implications are always not immediate but rather a long-term impact. Bonaparte communities may benefit from commercial and employment opportunities as a result of industrialization for the processing plant [22]. For example, Figure 3 shows an increase in employment rate of Australia in the oil and gas sector from 1984-2014.

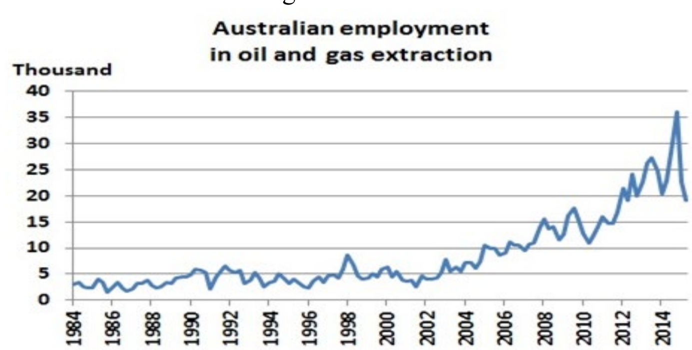

Figure 3: Australian oil and gas employment rate (Australian Mining 2016).

Mitigation:

Integrated Gasification Combined Cycle has been proven as a modern technology that is environment friendly which can be used to generate power with less methane and other greenhouse gas emissions [23]. Alternatively, the use of renewable sources of energy (such as solar power) is always in support to mitigate the strength of potential emissions and subsequently global warming [24]. Meanwhile prohibitive cost of maintenance and less efficiency has been a major drawback in the alternative use of the renewables in most instance [25]. Bonaparte communities prone to impact of emissions should be involved to create health awareness for precautious actions.

Transportation:

Pipelines of several metres to be laid on top or underground for the gas transport from Wagon Creek gas field to storage and distribution units. Soil tunnelling and underground movement have been observed as the impact of pipeline installation on the lithosphere [26]. Figure 4 shows a site project activity for pipeline installation. This activity has a negative impact on the loss of vegetation and biodiversity [27].

Figure 4: Pipeline installation project activity (FEMA 2013)

Bonaparte region in the Northern Australia usually experience rainfall fluctuations with rise around December [28]. Figure 5 shows the 2015 annual rainfall distribution. As expected to commence the project around December, preferential flow could enhance the risk of methane leaching to underground water [29]. With cause of time pipeline corrosion leading to may contaminate soil and rivers along its way [30]. Hence, the elevated value of 98502.60MMscf methane gas potential emission during the transmission stage might be translated as likely due to pipeline leakages.

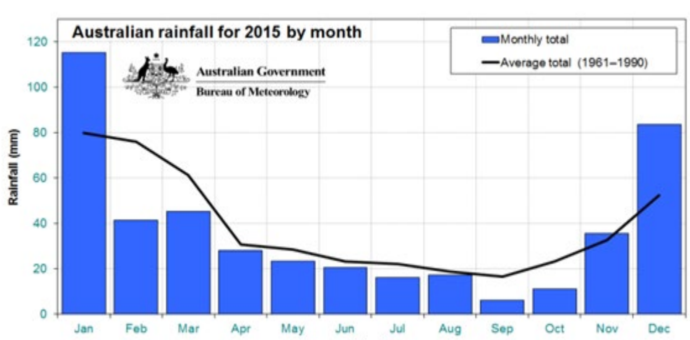

Figure 5: 2015 annual rainfall distribution in Australia [31].

Mitigation:

To mitigate pipeline leakages, pipeline leakage detectors can be installed on pipes to inform operators of leakages along transmission [32]. Affected farmers should have compensation for their land and were possible establish the project on previously disturbed sites. Furthermore, local stakeholders should be early involved to identify environmental sensitive areas [33].

Distribution:

The combustion power of hydrocarbon gas is the basic property leading to fire outbreak or explosion if not properly handled [34]. This is usually being the case at gas distribution centres. Potential methane emission data from the Wagon Creek gas field shows that substantial amount of methane emitted during distribution more than the processing stage. Beside climatic impact of methane, Sirdah, concluded a research that workers at distribution centres confirmed to be at higher risk towards clinical abnormalities [35]. Road networking and the development of distribution site were also another claim for land use in the cause of the gas distribution. Figure 6 shows a picture of gas distribution station together with its workers.

Figure 6: Workers at gas distribution station [36].

However, on the positive scale these workers earn their living from the distribution station as employed staff. Hence Wagon Creek field gas distribution also expected to create jobs and other opportunities to host and nearby communities. A report from Tanzanian community located near to industrial area revealed that 8.1% of individuals benefit from direct activities as a source of employment while another 37.8% benefit from food sales [37].

Mitigation:

Provide health and safety program to workers and public to understand implications related to gas distribution [38]. The use of appropriate distribution procedure with modern technology should be adopted to reduce potential emissions. Distribution centres should be sited away from residential areas like the Whindham Town and Port while making adequate compensation to farmers and other land owners.

Although Environmental impact analysis aid to address environmental planning for both new and existing projects, it is impossible to totally mitigate environmental consequences of the Wagon Creek gas field [39]. This is because "it is intrinsically possible to design industrial processes that have no negative impacts" [40-51].

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