An analysis of environmental obligations and liabilities of an electricity distribution company to improve sustainable development

Aphelele Tomsana¹ · Elie Fereche Itoba-Tombo¹ · Izanne Susan Human¹

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Abstract

Concerns for the environment and the desire to secure sustainable development are often too difficult to achieve considering the pressure put on natural environment. Worldwide, environment must be protected to ensure social and economic development for the benefit of the existing and forthcoming generations. Developing countries ought to prioritise the protection of the environment over the exploitation of natural resources and environmental pollution. South Africa has incorporated the concept of sustainable development in the Bill of Rights in the Constitution although the country is still facing difficulties. This research article aims to analyse environmental obligations and liabilities of an Electricity Distribution Company to improve sustainable development. Environmental obligations, liabilities and sustainable development are identified to realize research objectives and respond to research questions. A correlation coefficient test is performed to determine relationship between variables. Positive (+ 1) relationship between variables was identified. The results demonstrated the electricity distribution company's performance on environmental obligations and liabilities for environmental damaged caused. The results help to understand how to protect the environment, prevent financial liabilities and improve sustainable development. The Electricity Distribution Company had environmental incidents, which triggered environmental obligations and associated liabilities to which hinders the ability to achieve sustainable development in a comprehensive scale such as killing and endangering of protected bird species. Sustainable development will be negatively impacted as the results demonstrated that some environmental incidents were not reported and incidents occurrence hotspots not identified. Consequently, this impacts negatively on the environmental integrity. Environmental Management System could assist to address environmental obligations and associated liabilities to improve sustainable development. The system provide an international standard that ensure proper processes, risk identification, environmental aspects with the sole purpose to enhance environmental performance, achieve environmental obligations and fulfil environmental compliance obligations.

Keywords Environmental protection · Environmental obligation · Environmental liability · Sustainable development

1 Introduction

Governments are aware of environmental issues worldwide and South African government are aware of environmental issues. The South African government have

developed environmental provisions in the Bill of rights in the Constitution of the Republic of South Africa Act No. 107 of 1996 [32].

The Constitution of the Republic of South Africa Act 107 of 1996 states that, 'everyone has the right to an

✉ Aphelele Tomsana, aphelelet@hotmail.com; Elie Fereche Itoba-Tombo, itobatomboe@cput.ac.za; Izanne Susan Human, humani@cput.ac.za | ¹Department of Environmental and Occupational Studies, Corner of Keizersgracht and Tennant Street Zonnebloem, Cape Peninsula University of Technology, P. O. Box 652, Cape Town 7925, South Africa.

environment which is protected for the benefit of the present and future generations, through reasonable legislative and other measures that improves sustainable development and the use of natural resources while, promoting economic and social development' [58].

Worldwide, the international communities have endorsed international environmental legislations, within its powers and understanding of environmental obligations to outline a duty of care for environmental degradation [51–58]. For example, Australia has established a sustainable development method to structure a policy framework for the use of natural resources without manipulation [15, 17]. There are numerous social and environmental issues between developing and developed countries, which makes it hard to achieved sustainable development such as poverty, industrialisation, inequality, climate action and environmental degradation [19].

South Africa is a signatory to international treaty such as the Kyoto Protocol of 2002; it is a developing country and therefore, has no obligation to reduce greenhouse gas emissions [48]. However, this contradicts with national environmental protection acts [58] which requires any person to take reasonable measures to prevent environmental degradation, hence improving sustainable development.

Environmental obligations and environmental liabilities differ in accordance with geographic setting where activities take place, as one geographic setting may have additional compliance obligations in a form of local or municipal by-laws, which are not applicable to other municipalities or communities. To link the results of environmental obligations and liabilities of electricity distribution company, it is important to be spatially explicit by mapping the incident location for environmental incidents so that all environmental obligations are understood and fulfilled in accordance with international, national, provincial and local by-laws [68].

When geographic location is known, it is easy to identify applicable environmental obligations and associated environmental liabilities such as international agreement, national, provincial, municipal environmental obligations.

2 Background to environmental obligations, environmental liability and sustainable development concepts

Environmental obligation is a compliance commitment between private and public authorities, which enforces a duty to safeguard the environment from the organisation's activities, products, or services and risks that could have detrimental effects on the environment [22, 44, 46, 62].

There is no exemption between a developing and developed country from prevention of environmental

degradation, environmental obligations and imposing an environmental liability. Any person, who cause environmental degradation while performing functions in line with his or her organisation or employment on behalf of the employer, may be liable in a personal capacity [1–60]. A clear relation is shown between environmental liability and environmental obligations which is caused by failure to adhere to environmental compliance obligation and that requires an environmental liability to rectify the effects of not adhering to such an obligation.

Environmental liability is a responsibility of every person to take reasonable steps to rectify the actions that have caused environmental degradation [6, 7, 63]. The environmental requirement to maintain and rectify environmental damage is necessary as constituted by environmental legislative framework to hold a person into account. Where environmental obligations have not been met, an environmental liability is then triggered, and environmental integrity is compromised [32]. Thus, negative impacts on the environment deprive the principle and ideal sustainable development.

Different environmental legislative frameworks regulate environmental obligations and liabilities. Some of environmental legislations to which the Company subscribes are shown in Table 1. The Company could not be named for confidentiality, competitive and legal reasons.

Sustainable development is an integration of social, economic and environmental aspects into the preparation, operation and management of the organisations activities, products and services to ensure that development serves the interests and benefits of current and upcoming generations [24, 27, 28, 37]. The protection of the environment can be achieved through voluntary environmental agreements where the Company subscribes to international standards for best practice such as environmental management systems [29–46].

South Africa as a developing country still faces sustainability difficulties, although the country has embraced the concept of sustainable development [5]. Organisational processes that safeguard the environment will develop significantly in a sustainable manner and improve sustainable development.

This research article has engaged in an in-depth and transparent discussion on the environmental obligations and associated liabilities to improve sustainable development by asking the following questions:

- To what extent does the Company comply with environmental legislation to fulfil its environmental obligations?
- What can the Company do to prevent or minimise cost related to environmental remediation and compensation liabilities?

Table 1 Some environmental legislation to which the company subscribes [16–51, 62–64]

#	Hierarchy of environmental legislation	Applicable Jurisdiction
1	United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, 3 to 14 June 1992 The World Summit on Sustainable Development held in Johannesburg in September 2002	International agreements
2	The Constitution of the Republic of South Africa Act No.107 of 1996 National Environmental Management Act 108 of 1998	National legislations
3	Free State Nature Conservation Ordinance No. 8 of 1969. Proclamation 113 of 1994. Government Gazette No. 15813. 17 Jun 1994 Free State Province Standard District Municipal Environmental Management By-Law. Provincial Notice 182 in Free State Provincial Gazette 80 of 9 December 2011	Provincial legislations
4	Masilonyana Local District Municipal Environmental Management By-Law. PN 182.2 of 10 April 2015 Xhariep District Municipality: District Municipal Environmental Management By-Law. PN 182 in Free State Provincial Gazette 80 of 9 December 2011 and adopted by Free State Provincial Gazette 58 of 19 September 2014	Local by-laws
5	240–101,385,485 Sustainability Mapping at Eskom: Eskom's Sustainable Development Framework. Climate Change and Sustainable Development	Company laws

- Which environmental management options will the Company use to improve sustainable development?

This research article mainly focused to analysis of environmental obligations and liabilities of an electricity distribution company to improve sustainable development. Sustainable development is paramount and beneficial to the present and forthcoming generations.

3 Methodology

3.1 Study area

This study was done at an electricity distribution company in Free State Province in South Africa. The total area of the province is approximately 129,825 km² and consist of six district municipalities namely, Xhariep, Motheo, Lejwerputswa, Thabo Mofutshanyane and Fezile Dabi District Municipality. The Company operates and maintain its electrical infrastructures to supply their customers across all the municipalities specified above.

The electricity voltage is strengthened through a transformer and transported to the Transmission Division power lines, which transmit the electricity into the Transmission Division substation transformers and from there, the electricity voltage is stepped down into Distribution Division power lines then into distribution division substations and municipality substations to be distributed to end users [11].

3.2 Study research design

Research design is a detailed plan used by the researcher to answer to questions accurately, authentically, objectively and equitably without preconception [8–35]. This

research article comprises of both qualitative and quantitative research methods that were used to collect, analyse and interpret data, and present research results to provide meaningful contribution to the research article.

A search query for this research article was undertaken using a Google scholar, which provided a published descriptive overview on environmental obligations, liabilities and sustainable development. The main search comprised of research title, abstract, author's keywords and literature review. The literature review focused on the scientific sources that clearly refer to the three research concepts namely, (i) environmental obligation, (ii) environmental liability and (iii) sustainable development.

This article covered the three concepts mentioned above on an international, national, provincial, local and organizational point of view. The researcher analysed the link on the research concepts and the electricity distribution Company's operations and maintenance business activities. Data about the electricity distribution Company's performance is analysed, interpreted and presented using both qualitative and quantitative research methodology to achieve the objectives of the research and respond to research objectives.

3.3 Description of variables

In this research article, independent and dependent variables were identified and relationship between them is calculated to test the correlation coefficient. A variable is an observed phenomenon that takes on diverse values [18–66]. It is a logic grouping of attributes, and attributes are characteristics that describe an object such as among other things, the age, environmental beliefs.

Two variables were established for this research article, namely;

- Environmental Obligation (EO) = Independent variable (X)
- Environmental Liability (EL) and Sustainable development (SD) = Dependent variable (Y)

Environmental obligation was identified as an independent variable for this article, while environmental liability and sustainable development were identified as dependent variables. Independent variable (X) is manipulated to determine the possible effect or brings about a change in an observed phenomenon, which creates the relationship with the dependent variable [34, 35].

Dependent variables (Y) are variables on which the effect is focused and assumed to depend on independent variable. It observes and measures the affected independent variable [36–67]. Dependent variables must change every time the independent variable changes, which demonstrate a relationship between variables as illustrated in Fig. 1.

The relationships and dependability between two variables are essential. Where there is no relationship between two variables, the effect is then rejected. An assessment of the status before and after environmental liability, and sustainable development is determined by the environmental obligation posed which then clarifies the benefit or the loss.

In this research article, there 17 possible statements that were explained to the respondents. Among the variables included in the analysis, a questionnaire scale was used to measure the level of agreement or disagreement with the statements provided. Five scales were given (Strongly agree, agree, neither agree nor disagree, disagree and strongly disagree).

3.4 Correlation coefficient tests

A correlation coefficient test between dependent and independent variables was calculated following r-square value method using Microsoft excel 365 software as shown in Fig. 1. Where correlation coefficient value of + 1 value is acquired, it indicates a positive relationship, where correlation coefficient value of 0 (zero) indicates no relationship and correlation coefficient value of – 1 indicates a negative relationship. EO (X) was assigned numerical values indicating environmental incident leading to a change into dependent variable.

SD (Y) was assigned numerical values indicating the impact on the environment caused by the environmental obligation. EL (Y) was assigned numerical values indicating environmental liability caused by the failure to honour environmental obligation.

When an environmental incident occurs, there is environmental obligation triggered, which requires a person to prevent the detrimental impacts on the environment (environmental degradation), and environmental liability (fine, clean-up or both) costs imposed [17]. The numerical values assigned to both independent and dependent variables illustrate the correlation coefficient between variables. A correlation coefficient value of 1 was observed which indicate positive correlation between independent and dependent variables.

As variable X increases, variable of Y increases. As variable X decreases, variable Y decreases. This scenario was experienced when the independent variables were manipulated and calculated the correlation coefficient.

The correlation coefficient calculation shown in Fig. 1 shall be read in conjunction with Table 2, which indicate correlation coefficient between independent and dependent variables in this research article. The correlation coefficient (CoE) is 1 when testing the correlation between

Fig. 1 R-square correlation test for variables

Table 2 Correlation coefficient calculation of relationship between independent and dependent variable(s)

Variable(s)	Value (s)			Coefficient (CoE)
Environmental Obligation (X)	1	2	3	1
Sustainable development (Y)	1	2	3	
Environmental Obligation (X)	1	2	3	1
Environmental Liability (Y)	3	6	9	

environmental obligation and sustainable development. This means that every time an environmental obligation is not fulfilled, the sustainable development is impacted negatively. Additionally, whenever environmental obligation is not fulfilled, the responsible party is ought liable to ensure that environmental damage caused is remediated [42].

This research followed a qualitative and quantitative research methodology, which enables the sampling methods that is suitable for this research article. A sampling methodology is select a smaller sample from a bigger group to develop the basis for calculating the occurrence of an undisclosed portion of data and a result regarding the bigger population [36–57].

The research followed a random sampling approach technique. A random sample delineates the nature of the population and all members have an equal chance of being selected [43]. The research was conducted in Free State Province in the electricity distribution company by sampling a smaller population based on random sampling approach.

3.5 Data analysis

Data analysis was undertaken where research objectives were tested against the research findings from the data collected. Microsoft excel 365 software was used to process research results and present them in a form of tables and figures to give a meaningful and understandable analysis for both qualitative and quantitative research methodologies, respectively. The researcher was assisted by the supervisor and co-supervisor to analyse all data collected for this research article. A qualitative data was analysed and explained in words while quantitative data was presented in descriptive statistics.

Qualitative data analysis mainly focused on the data collected through site investigation, while quantitative analysis focussed on the data collected using SAP EHS Incident management and research questionnaire. Microsoft excel 356 software was used to perform a correlation coefficient calculation between independent and dependent variable to determine whether there is any relationship

Fig. 2 Bird Mortality Incidents reported in different localities according to years

among variables identified in this research article. The software presented findings of data collected following a quantitative research methodology.

A variable correlation data analysis was performed between independent and dependent variables to provide a meaningful understanding of how environmental liability and sustainable development are influenced by environmental obligations.

4 Results and discussion

4.1 Results

The results on this research article are presented in figures with corresponding interpretations. These results are from the data collected using research methods explained in this research article to respond to research questions and objectives regarding the analysis of environmental obligations and associated liabilities to improve sustainable development.

The work is structured in the followings sub-headings;

4.1.1 SAP EH&S incident management system

In the present research, all environmental incidents that were reported to the electricity distribution company and captured using the SAP EH&S Incident Management software during the research period of this article between January 2014 to August 2017 were drawn and analysed to present the research results. The environmental incidents were presented according to the incident categories specified in Figs. 2, 3, 4, and 5. The environmental incidents presented are those presented are only those in the figures

Fig. 3 Oil spillage Incidents reported in different localities according to years

Fig. 4 Veld Fire Incidents reported in different localities according to years

below as reported by the electricity distribution company using SAP EH&S incident management system.

Bird mortality incidents were reported into the electricity distribution company as shown in Fig. 2. The areas are indicated in the legend and number over incidents that were reported are label for each town. The bird mortalities were caused by bird colliding with the power lines due to poor power line visibility for birds to avoid the power line during sunrise or sunset and where there is a mountain on the background making the power line invisible. It is essential to protect biodiversity that is threatened or in need of protection to ensure that their environmental integrity is maintained which gives the effect to environmental obligation under international agreement and manage biodiversity in an environmental sustainable manner [61].

Some of the bird mortalities reported in Fig. 2 were because of bird electrocution. Electrocution is caused

Fig. 5 Animal Electrocution Incidents reported in different localities according to years

by bird touching a live conductor that are not insulated, such as touching a red phase and white phase, blue phase with earth bonding wire or white phase with any other phase (Red, White or Blue) at once, bridging the clearance, touching earth bonding wire that is not gapped to prevent electrocution.

In 2014 Bethlehem reported one bird mortality, Welkom reported one bird mortality in 2015 and in 2016 Bloemfontein area also reported one bird mortality. These results show that the incidents alternated among areas for four years and three of the years there was only one incident reported a year. In 2017, there were three bird incidents reported in Kroonstad as shown in Fig. 2.

Oil spillage incidents were reported as indicated in Fig. 3. When oil spillage incident occurs in the ground, it causes land pollution, burn the vegetation, water pollution, pose fire risks and visual impacts. When these environmental incidents occur, they defeat the ideal sustainable development. Thus, the electricity distribution company is required to take reasonable measures as per its environmental obligations and liabilities.

Veld fire incidents were reported by the electricity distribution company as shown in Fig. 4. These incidents do not only result to air pollution with degrade the air quality, it also kills or burn animal and plant species. The fires also burn the wood electrical structures which the lead to poles falling on the ground and pose a risk of electrocution.

The reason for the three incidents in 2017 were among other things; the vulture restaurants near the power lines and the awareness of the need to report incidents and capturing into SAP EH&S incident management process.

Oil spillages incidents that were reporting during the research period of this article are as shown in Fig. 3.

These environmental incidents posed an environmental liability to the electricity distribution company to ensure that the pollution caused on the environment is cleaned. Every person who during the execution of his employment duties caused a significant environmental pollution is environmentally obliged to prevent pollution and where pollution cannot be prevented, the person is environmentally liable to remediate the effects of that environmental pollution [59, 60].

In Welkom, there were 12 oil spillage incidents, which were reported in 2014, five oil spillage incident in 2015 and six oil spillage incident in 2016, while in 2019; Welkom reported two oil spillage incidents, which were equal to the incidents reported for Kroonstad in 2017 as shown in Fig. 3. These results demonstrate that Welkom dominated the other town in the number of oil spillage incidents reported. In the year 2017, incidents reported zero or no oil spillage for Bloemfontein. These results indicate that there was no required environmental liability for the cleaning of the environment from oil spillage.

In 2014, 2015 and 2017, there were one oil spillage incident reported for Bethlehem, while there was only one oil spillage incident reported in 2016. These results demonstrated that Bethlehem has been trailing behind other areas in oil spillage incidents for all the years of the study period, respectively except in 2017. The oil spillage incidents reflected in Fig. 3 were a result of equipment and bushing technical failures, transformer vandalism by unknown persons and transformer caught fire.

The number of veld fire incidents were organized in accordance with the year to which the incident was reported and presented in Fig. 4 to illustrate all incidents in accordance with the areas to which the incident had occurred. These incidents were reported for four years between 2014, 2015, 2016 and 2017 to enable a valid analysis of the environmental obligations. Every landowner has an environmental obligation to prepare and maintain a fire breaker, which should be wide and long enough to have a reasonable chance to stop the spreading of veld fire to or from a neighbouring land [60].

There were more veld fire incidents reported for Bethlehem across all the four years as shown in Fig. 4. While there were zero incidents reported for Welkom across the four years. In 2015, 2016 and 2017, there were no incidents reported for Kroonstad, which means that environmental was not damaged by veld fires and no environmental liability imposed.

These veld fire incidents were due to among other factors; landowner igniting a fire to prepare fire break and loss control of the fire, live conductors clashes and create a flashover which ignite the fire, damaged cross arms and broken wood poles, etc.

Animal electrocution incidents are among other environmental incidents which carries an environmental obligation to electricity distribution company to protect the animals providing electricity by insulating and maintaining the electrical infrastructure. When an electrocution incident occurs, the electricity distribution company is required to determine the cause of the incident and where the faulty is on the Company's side, the Company is financially liable to compensate the owner other than animal or game.

The animal electrocution incidents occur because of among other things, animals rubbing themselves against the wooden powerlines and the pole fall then the animal come into contact with the live conductors, where wood poles structures were burnt during veld fire incidents and when a storm hit the area the poles fall down and animal come into contact with live apparatus. Additionally, animal electrocution occurs where the electrical infrastructure or wood structures are short, and the landowner introduces long animals like Giraffe breach the clearance. Electricity has a capability of jumping, sometimes you do not need to come into contact, so when the clearance is breached, the animals get electrocuted.

There were more animal electrocution incidents reported in the year 2015 and no electrocution reported in the year 2017 across all the areas as demonstrated in Fig. 5. The term environment is a broad term used to describe animals and plants species. For the purpose of this article, the term was used in animal context, however, did not differentiate between domestic and wild animals. The researcher collected and analysed data in relation to animal electrocution that were reported by the electricity distribution company.

There were no animal electrocution incidents reported for Welkom the four years in a row as illustrated in Fig. 5 starting from the year 2014 to 2017. Most incidents were reported for Bethlehem and Bloemfontein between year 2014 and 2015 respectively. These incidents demonstrate an environmental obligation to protect the animals and environmental liability in a form of compensate for electrocuted animals. As illustrated in Fig. 5 Bloemfontein and Bethlehem reported the most animal electrocution incidents than Kroonstad. Welkom did not report any incident, which demonstrate little or no environmental obligation and liability related to animal electrocution.

The environmental liability imposed has compromised the ideal sustainable development as the death of these animals, which are part of the environment, lead to financial liability. It could also lead to a public outcry from nature conservation organisations, interested parties and government.

4.1.2 Questionnaires

The respondents were provided with a questionnaire, which was in a form of a Likert scale. The questionnaire contained a statement to which the respondents were requested to respond on. In this research article, perceptions about the statements provided were measured using a Likert scale where statement were provided to the respondents requesting them to state the extent of agreement with the statements [2–65]. Some of the respondents did not participate in this article due to numerous reasons, which demonstrated that they were unwilling to participate in this article.

The response rate was 37.5% from work coordinators and 67.44% from supervisors. The value and validity of the results have reached an acceptable level and enables the research to draw conclusion. When a response rate is less than 30% from the sampled population, the value and validity of the methods and results are questionable [23]. The questionnaire responses were group into three concepts of the research upon analysis to provide a clear view of the concepts and participants responses. The results in connection with the identified concepts in this article are presented below.

The participants responded to all the questions on the research questionnaires related to three environmental concepts namely; environmental obligations, environmental liability and sustainable development as presented in Fig. 6 above. The questions in the research questionnaires that were distributed to the respondents were intended to answer the research objectives and questions where respondents had to indicate their perceptions or extent of agreement with the statements. The respondents had five options to silent from namely, strongly agree, agree, neither agree nor disagree, disagree or strongly disagree.

The analysis of the questionnaire responses are divided in accordance with the research concepts as presented below.

4.1.2.1 Environmental obligations The responses to statements regarding environmental obligations indicates that most respondents strongly agree and understand environmental obligations concept which is followed by those that agree to the concept as presented in Fig. 6. This indicates from electricity distribution company fulfil its environmental obligations that arise and related to its operations and maintain activities, products or services and risk. The activities, products or services are identified, collated and documented as environmental aspects and impacts register which assist the electricity distribution company to fulfil environmental compliance obligation. Thus, contribute to protection on the environment and contribute into achieving sustainable development. There were numerous respondents which were neither agree nor disagree with the statements about environmental obligations which they pose environmental risks or opportunities related to environmental obligations.

Environmental obligations require that any person who operates in the environment and, whether accidental or by other occurrences, to be obliged to prevent, notify and manage environmental degradation [21–69]. As illustrated in Fig. 6, those strongly disagree, disagree and neither agree nor disagree requires the companies intervention to make them aware of those environmental obligations related to electricity distribution company activities, products or services when they perform the company duties and responsibilities. The environmental awareness and training are itself an environmental obligation impose to the company to make sure that every person that do work on the company's behalf is competent on basis of training,

Fig. 6 Participant response from questionnaires

awareness or work experience. Those respondents are posing an environmental risk to the electricity distribution company by not knowing what they are environmentally obliged to do when undertaking their duties.

4.1.2.2 Environmental liabilities Environmental liability is not dependent on whether that position of the land is owned by an individual but rather where there is environmental degradation of that land, the person who is responsible for such a degradation is deemed environmentally liable for the remediation of that land or compensate the re clean-up of that land [17–69].

Several statements related to environmental liability were incorporated into the questionnaire sent to respondent to provide response. The statement in required perceptions to understand how the respondent understood and applied environmental liabilities that poses by the failure and likely failure of not fulfilling environmental obligations which then lead to environmental liabilities of the electricity distribution company. Environmental liability is required if understand would help prevent environmentally liable to prevent and clean-up the effects of pollution that happened while working for the electricity distribution company. At least some respondents disagreed, and other respondents strongly disagreed with the statement provided as illustrated in Fig. 6 indicating that even if one is working on behalf of the Company, the person may be personally liable to remediate the effects of pollution caused on the environment.

These results agree with [59] that any person who does or omit to do a task that has been his or her the employer, constitute an offence and that person shall be environmentally liable to remediate the effects of environmental degradation. There are several respondents who strongly disagree, the others agree, and some respondents disagree with the statement that the electricity distribution company cannot be found liable for non-compliance with the South African environmental legislations when they conform to their internal business procedures.

This demonstrates that most respondents do not understand that South African environmental legislations supersede the Company's internal business procedures. It is not adequate to only conform to internal business processes as they are governed and shall be aligned with the Country's environmental legislation frameworks.

4.1.2.3 Sustainable development Sustainable development aimed at the protection of the environmental factors while promoting social and economic growth [37–50, 64]. Most respondents strongly agreed and agreed to the concept of sustainable development. There were no respondents that strongly disagree or disagree with the concept of sustainable development. While there were a

few numbers of respondents whom neither agree nor disagree four questions related to sustainable development as presented in Fig. 6. These results provide a clear understanding that sustainable development is understood and for this reason, the environment would be protected for the benefit of the present and future generations by taking reasonable measures. The sustainable development can be achieved by protecting environmental damage through adhering to what is acceptable by prescribed environmental legislation of the country.

Environmental damage does not only consider the negative impact on the person's property, but also determines the impact on the natural environment collectively [54–69]. Sustainable development requires the attention of all-important factors, which comprises of among other things; avoiding the disturbance of ecosystems and loss of biological diversity, where they cannot be avoided; they are minimised and remedied [59].

The questionnaire responds provides a better understanding of how a person perceives environmental obligations, environmental liabilities and sustainable development while conduct the duties of their employment. Sustainable development comprises the internalisation of environmental costs into decision making for economic and other development strategies, programmes and projects, which have the potential to impact on the environment [52].

4.1.3 Site investigation

Site investigation provided a status of environmental incidents that were found on site, which prompted an environmental obligation to prevent incidents and report upon occurrence. The environmental incidents lead to environmental liability, which requires that detrimental effects on the environment remediated to achieve sustainable development.

Site investigation assist to ascertain the work done and analyse where and how the task has been executed [12]. The oil spillage incident occurred from 10MVA transformer that contained approximately 2000 L of oil, which provides 132/22 kVA electricity supply. A contractor was appointed to clean-up the effects of environmental pollution cause on the environment.

The reasons for the oil spillage incident were due to mechanical failure on the transformer, which posed an environmental liability to remediate the effects of environmental pollution. When an incident occurs, the Company is therefore required to take reasonable measures to prevent environmental pollution. The Company shall minimise and remediate the effect of environmental pollution or degradation, where it cannot prevent environmental pollution [21–53]. The Company outsourced a service from a

contractor to remediate the environmental pollution and compensate the contractor in a form of payment for work rendered.

All faulty oil containing equipment must be placed on an impermeable floor to ensure that in case the oil spills, the environmental pollution would be prevented. The oil containing equipment found on site were among other things, Current Transformer, NEC Transformer, Breakers, etc. The reasons for oil spillage incident are because of among others; the mechanical failures, oil tap opened by unknown person, vandalism and lightning strikes the transformer.

The Company did not have a proper storage area such as a bund wall or cemented floor designed for placing oil containing equipment. Some of the oil containing equipment were not placed in impermeable floor as required and the oil leaked and penetrated through the soil. The depth at which the oil had penetrated could not be determined. The Company appoint the external service providers to remove the scrap materials to prevent further oil spillage and clean-up major oil spillage incident to remediate the effects of pollution on the environment.

Several initiatives were done where a container was placed underneath the leak to prevent further oil spillages on the ground. This was indication to take measure to prevent environmental pollution by placing a container underneath the oil dripping area. The person was aware that environmental pollution poses detrimental effects on the environment and the Company must ensure that environmental pollution must be prevented. The oil spillage was caused by technical failure on the transformer leading to oil spillage on the ground. The depth at which the oil spillage penetrate could not be determined. However, according to personal observation, the oil spilled to approximately 30 mm into the soil and gravel stones.

Some of the oil spillage incident that occurred due to an explosion from an NEC Transformer, causing land pollution inside the substation. The Company requires a work stoppage to be able to perform the required maintenance of the NEC Transformer, which resulted in power cuts to the customers that receive power from the substation. The Company is obliged to undertake maintenance of the NEC Transformer forms part of regular maintenance and when a technical failure on the transformer site is noticed during monthly inspection at the substation.

When the Company does not adhere to its environmental obligation, then the Company becomes liable for the clean-up. Anybody who causes, has caused or may cause environmental degradation is environmentally obliged to clean up the effects of such an environmental degradation [64].

Due to number of incidents that had occurred during the Company's operation and maintenance, there were several environmental liabilities and financial value assigned to the liabilities for among other things veld fire incidents and animal electrocution as shown in Fig. 7. These incidents were presented to the Public Claims Committee to decide whether the Company was the cause of the incident and determine whether there is anything that could have been done to prevent the incident. Once that is determined, it becomes clear to whether the Company failed to adhere to its environmental obligations and determine the appropriate liability that has been incurred.

The Public Claims Committee is a committee formed to look at all incidents that happened due to the Company's failure or negligence to fulfil its obligations that range from among other things, environmental obligations, safety obligations, property damage, etc.

The financial liability cost presented are for environmental incidents that occurred in the year 2015 and

Fig. 7 Financial liability cost for environmental claims incurred

2015 due to the availability of the data at the time of this research article. The reason for non-availability of financial cost information was but not limited to pending incidents where the committee had not ruled on the matter and sent through to insurance department for capturing and processing payment at the time of the research article.

4.2 Discussion

This section provides an overview of the meaning of the results provided in this researcher article. Most bird mortality incidents reported occurred in Kroonstad in the year 2017. This demonstrated that there were more environmental obligations and environmental liabilities that the electricity distribution Company incur in the area during its operations. The incidents were due to electrocution of birds on bird unfriendly structures, uninsulated conductors, not cutting a safe clearance gap on earth wires, vulture restaurants in proximity with the powerline, etc. Some of these incidents were due to bird colliding with electrical infrastructure due to invisibility of the power line on sunset, sunrise and during the night, powerlines cross over and near a dam, a mountain on the powerline background of the powerline, etc.

The Company is obliged to prevent all electrocution of bird species on its electrical infrastructures as this impact negatively on the biodiversity where there protected bird species will go to extinct. When sustainable development is not achieved as prescribed in sustainable development goals, the environment will be degraded, veld fires kill plant species and animal species will go to extinct that will result to the next generation not benefitting and gain knowledge of those species which the current generation enjoyed.

The Company will experience number of environmental liabilities related to mitigating the electricity distribution structures to make them friendly for birds, prevent veld fires, animal mortality and environmental pollution clean-up related to oil spillage incidents, which would affect the company heavily on financial liability costs.

The veld fire incidents occurred the most in the year 2014 in Bethlehem due to clashing among other things clashing of conductors on stormy conditions, landowners preparing fire breaker, etc. Most animal electrocution occurred in 2015 between Bethlehem and Bloemfontein area. A link could be made between veld fires and animal electrocution, as the burnt wood poles are east to fall on stormy conditions posing a risk of animal electrocution when conductors fell on the ground. The Company is obliged to conduct site inspection and regular maintenance of its electrical infrastructure thus prevent incidents.

Numerous oil spillage incidents were reported in Welkom area for the year 2014. The environmental legislations oblige

everyone to prevent the incident from occurring and report them when they occur. Once the incident is reported or found, it poses an environmental liability to remediate the effects of environmental degradation on the environment. Most incidents that occurred in Welkom were due to among other things transformer vandalism by unknown persons, blown transformer due internal technical failure, etc. When environmental incidents occur, the environment get detrimental affected.

The Company losses a big amount of money rectifying the effects of environmental degradation caused on the environment and compensating the parties affected. Once the environment is polluted, it becomes difficult to the return the state of the environment to its original state. Thus, it is difficult to achieve sustainable development. The remediating of the effects of environmental degradation plays an important role in protecting the environment and achieve sustainable development for the benefit of the environment and its people.

The response from the questionnaire provided an insight that some respondents knew the environmental obligations. However, some respondents had a different view and that environmental liability must not be imposed on the individual in personal capacity, as the person would be working on behalf of the Company. The receiving environment do not differentiate the environmental pollution from an individual person or the Company.

The extent to which respondents agreed with the statements provided in the research questionnaires are studied to determine the correlation with the data collected in this article. A correlation coefficient value of + 1 which is a positive relationship between independent and dependant variable were found in this research article. This correlation coefficient test proved that environmental obligation is an independent variable while both environmental liability and sustainable development were dependent variables.

The results of this research article are mindful of three aspects of sustainable development, which include protection of the environment, social consideration and economic development while conducting business and the use of natural resources. Previous studies [19–24, 55] summarised that a fundamental goal of sustainable development is to preserve and use the available natural resources while preserving them for the future. This means that everyone must ensure to minimise depletion of natural resources and not exceed the carrying capacities of the ecosystems (Table 3).

Table 3 Environmental issues and practices leading to poor practices of electricity distribution [40]

Incidents	Contributing factors	Environmental impacts
Oil spillage	Equipment failure due to lighting strike and internal mechanical or technical faults Oil containing equipment not placed on a secured ground such as drip tray or bund wall Employees not aware of their environmental obligations An opening of oil transformer taps by unknown persons Vandalism of transformer by unknown persons Absence of proper storage facilities and poor housekeeping	Environmental degradation Land pollution Water pollution Negative impact on sustainable development
Veld Fires	Landowner igniting a fire to prepare fire break Loss control of the fire, Live conductors' clashes and create a flash-over which ignite the fire, Damaged cross arms and broken wood poles, etc Melting of plastic made raptor protectors and bird flight diverters	Loss of biodiversity and vegetation Soil erosion Air pollution Bird mortality and injuries
<i>Bird Electrocution:</i> Scenario where bird causes a short circuit by physical bridging the air gap between live components, other live and grounded components	<i>Electrocution:</i> Small clearance between two live conductors or phases Small clearance between live and earthed conductors Position of jumpers, earth wire and arching horns Structure do not allow sufficient perching space for sociable species Wet feathers increase conductivity and lead to risk of electrocution Bird unfriendly structures located on higher topographic areas Bird lose balance on the pole top when fighting or mating Large wingspan and body leading to breach of clearance Basic Insulation Level (BIL) gap not cut, and earth spikes conductor not cut Bird flight diverters not installed on electrical structures Raptor protectors not fitted on electrical structures	Loss of protected bird species Declines vulnerable, threatened and near-threatened bird species Depletion and deny future generation a benefit to appreciate, learn and view bird species Loss of environmental integrity and ideal sustainable development

Table 3 (continued)

Incidents	Contributing factors	Environmental impacts
<i>Bird Collision:</i> Scenario where bird physically strikes either the conductor or the earth (shield) wire of an overhead power line while in flight	<p><i>Collision:</i></p> <p>Body size and flight behaviour of the bird</p> <p>Species that fly in larger groups reduce the space for avoiding obstacles and the visibility ahead for the bird at the back of the group</p> <p>Flight height where birds fly at low altitude, high frequency of overhead lines crossing such as flight between foraging and roosting areas</p> <p>Unfavourable weather conditions with high velocity winds, heavy fog or mist and heavy rainfall</p> <p>Time of the day where birds fly before or after sunset</p> <p>Topography influence bird movement and visibility of overhead power lines</p> <p>Conductors obscured against dark background which increase potential for collision such as mountains, river valleys and shorelines</p> <p>Land use, vegetation type and water courses such as cultivated grains and pasture crops, irrigated lands, rivers, dams, lakes and pans</p>	<p>Loss of protected bird species</p> <p>Declines vulnerable, threatened and near-threatened bird species</p> <p>Depletion and deny future generation a benefit to appreciate, learn and view bird species</p> <p>Loss of environmental integrity and ideal sustainable development</p>
Animal Electrocution	<p>Burnt wood poles due to veld fires then fall</p> <p>Storms and strong winds leading to live conductors being on the ground</p> <p>Lightning strike wood poles leading to live conductors being on the ground</p>	<p>Animal electrocution</p> <p>Loss of wild and domestic animals</p> <p>Loss of biodiversity</p>

5 Conclusion and recommendations

5.1 Conclusion

Based on the results of this research article, the following conclusions were drawn.

The incidents demonstrated that there were various environmental incidents which occurred during the electricity distribution company's operations and maintenance of its powerlines. The incidents triggered environmental obligations for the company to report those incidents and take reasonable measures to prevent further environment incidents which negatively impact on the environment, thus deprives sustainable development. There were hotspots identified where incidents mostly occurred, which enables the company to understand its areas and relevant environmental legislations that comes in a form of environmental obligations per local by-laws, provincial, national and international agreements.

The incident acquired using SAP Environmental, Health and Safety Incident Management Software provided only environmental incidents that were reported, which raise a question of the other incidents that might have not been reported. The environmental legislative requirements and the company's internal procedures

place an environmental obligation to the electricity distribution company to investigate further the incidents which might have occurred but not reported. The investigation would provide a clear guide on the processes and plans that must be in place to prevent or minimise the environmental incidents.

The incident drawn using the software provided a good understanding of the type of environmental incidents and the hotspots or areas where the incident happens in big numbers. The research questionnaire provided an understanding where conclusion can be drawn that some employees in the company do not fully understand their environmental obligations and associated environmental liabilities, which will make it difficult to achieve sustainable development. The company is therefore in a risk to incur environmental liabilities for among other things, the remediation of environmental damage and insulating their electrical infrastructures.

The use of research questionnaire provided the answer to reporting of environmental incidents. Respondents indicated that they neither agreed nor disagreed with the statements related to the reporting of incidents, which indicated that the Company is reporting environmental obligation still requires more interventions. Additionally, many respondents were not

sure about individual personal liability for the failure to perform tasks on behalf of the Company.

Site investigation provided an input to draw a conclusion that the company did fully comply with environmental legislation and its environmental policy which set commitments to prevent environmental pollution, report all environmental incidents and provide environmental awareness and training to its employees. This conclusion is drawn based on oil spillage incident found during site investigation where oil spilled on the ground. The company had to ensure that environmental rehabilitation is made.

A link between independent variable and dependent variable was determined between environmental obligation is independent as prescribed by environmental legislations. Upon calculating the correlation coefficient between the identified variables, a positive relationship was realised. The improvement of sustainable development is also dependent on adhering with prescribed environmental obligations and liability on the environment.

The Company implements remedial actions for environmental incidents by initiating clean-ups or appointing a contractor to remediate or rehabilitate the effects of environmental damage on the Company's behalf. For this reason, the sustainable development is likely to be achieved by restoring environmental integrity.

An establishment, implementation and monitoring of environmental management system can assist any person to adhere to environmental obligations and liabilities to improve sustainable development. Environmental Management System assist to identify their environmental aspect, risks and opportunities, put leadership commitment at the centre of business improvement and environmental performance.

5.2 Recommendations

Based on the results and conclusion presented in the research article, the following recommendations are suggested to ensure that the environment is protected, social aspects are considered and economic development is achieved while conducting business and that the use of natural resources is for the benefit of the present and forthcoming generations.

The first thing is to identify the environmental obligations and liability for the entire incidents that occurred and their locations. This will assist to prioritise mitigation measures and provide resources to protect the environment and improve sustainable development. The electricity distribution company is shall undertake the following;

- Identify activities, environmental aspects, risk and opportunities, and environmental compliance obligations.
- Identify the types of environmental incidents, location and municipal jurisdiction to determine the environmental legislation applicable. Conduct regular inspection and maintenance of electrical infrastructures to prevent environmental incidents.
- Build an impermeable floor that will prevent oil spillage from penetrating through the soil and causing environmental pollution. All people working for the electricity distribution company must receive environmental training suitable so that there will be no environmental pollution.
- Environmental Management System ISO 14,001 2015 must be implemented and monitored to continual improve environmental performance, met environmental objectives and adhere to compliance obligations.
- The leadership must be at the centre stage of all business processes ensure that environmental obligations are adhered to.

The benefit of knowing and adhering with environmental obligations is that it minimises and prevent environmental liability claims that the person must pay for remediation of the effect on the environment, compensate the person of the affected property. The utmost benefit of a clean environment is that the environment takes care of its people and natural resources thus secure sustainable development.

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Availability of data and materials Data and additional materials are available on request.

Compliance with ethical standards

Conflict of interests The author(s) declare(s) that there is no conflict of interest.

Research involving human participants and/ or animals The research article complied with the research ethics guidelines provided the Eskom Holdings SOC Ltd (electricity distribution company) and Cape Peninsula University of Technology, respectively.

Informed consent Prior to answering the questionnaire, participants were presented with an informed consent form, which explained what the study was about, the potential risk, right to withdraw, etc. The informed consent to participate in the research article, which participants agreed to prior participating into the research, read: "By completing and submitting this questionnaire, you are free and informed consent is implied and indicates that you understand the above conditions of participation in this research."

Appendix 1: Description of the research questionnaire statements

This appendix provided participants with statements to rate their level of agreement with the statements. Kindly read the statements in conjunction with Fig. 6. The appendix provides understanding of the data analysis of the research questionnaire results. See Table 4.

Appendix 2: Comments (C) and Response (R)

C1. Reviewer #4: (1) Title of the article is bit confusing. It looks that we are going to read something about distribution system of physical product. Therefore, it is

recommended to reword the title so that it can reflect that the article is about electric distribution company.

R1. An Analysis of Environmental Obligations and Liabilities of an Electricity Distribution Company to Improve Sustainable Development.

C1. The article has mainly discussed biodiversity issues like birds and animals. It should also include plant diversity. When electric distribution lines are developed, many trees are cut. That aspect is missing in the article.

R2. The aspects covered in the research articles comprises of birds, animals due to electrocution and collision, plants due to veld fires, land degradation and vegetation due to oil spillage incidents.

C3. Article needs significant work on methodology aspect. It is being mentioned at various places that it has used qualitative and quantitative method. But article lacks proper description of both these methods. What are the issues for qualitative research? How data was analyzed? Further, for quantitative research, how questionnaire was developed?

R3. Research methodology is explained, advantages and disadvantages of using the chosen research methodology incorporated into the research article.

Table 4 Statements for the research questionnaire

#	Statement
S1	Knowing the electricity distribution company's activities, environmental aspects and impacts helps to identify environmental obligations and associated liabilities
S2	When an incident occurs in your area, you are required to remediate the effects of that incident
S3	The electricity distribution company is not obliged to adhere to the country's environmental legislation when the Company has its own legislation
S4	There is nothing reasonable the Company can do to stop the fire from spreading, as the fire can jump
S5	All environmental incidents must be reported, irrespective of who caused the incident and the extent of the impact on the environment
S6	When working on behalf of the Company and environmental pollution occurs, you cannot individually be held liable for not preventing it or cleaning it up
S7	The Environmental Management System is the best tool for attaining sustainable development
S8	The Company cannot be found liable and punishable for disregarding the country's environmental legislation while the Company fully complies with its environmental policy and legislation
S9	There is no need to inform landowners about environmental incidents that occur on their land
S10	Sustainable development is achieved through preservation of environmental integrity
S11	The Company's failure to apply environmental management deprives the current and upcoming generations of their environmental rights
S12	Some environmental incidents are not reported to the electricity distribution company for capturing on the SAP EH&S Incident Management System
S13	The Company spends a lot of money for cleaning up and compensation for environmental incidents due to the nature of its business
S14	An environmental obligation means you have a duty to care for the environment at all times
S15	Environmental liability means that you are accountable to a fine, compensation or clean-up for environmental damaged you caused on the environment
S16	Sustainable development means protecting the environment while promoting economic and social development
S17	Environmental training is required to provide environmental awareness to everyone in the business

R4. The analysis of those of the methodology is explained and how questionnaire was developed using a Likert scale technique.

C4. Reviewer #5: +Too much data was presented and consequently it was not thoroughly analyzed and brought to a comprehensive whole. It would have been much better if the author/s focused (and presented) a specific aspect and dealt with it in detail.

R5. Presentation of data has been minimised to ensure clear presentation. However, where data could not be presented in a minimised, it has been simplified.

C5. The Methodology section could do away with descriptions on qualitative and quantitative methods (that are more suitable for a thesis rather than a research article) and focused more on the specific aspects of the methodology used in the research.

R6. Methodology related to this research article has been revised to make a clear logic understanding regarding this research article. Both research methodologies used are explained, disadvantages and advantages incorporated.

C6. The results from the questionnaire could have been presented in a more reader-friendly format that could facilitate interpretation. For example assigning simple numerical values to the responses could have done away with the confusing charts presented. Furthermore, a table with all the questions grouped according to the identified concepts could have avoided unnecessary wording and facilitated interpretation.

R7. Result presentation figures have been revised and those that do not give a clear meaning were removed. Presentations related to single aspects were grouped together.

C7. The Discussion and Conclusion are essentially a rehash of the results presented earlier. There is very little effort to relate findings to local/international reports/research articles.

R8. Discussion and conclusion has been revised to respond to research objectives, questions and results for this research article.

C8. The term "sustainable development" implies finding a balance between environmental, social and economic concerns in decision-making. The use of the term "ecologically sustainable development" tends to shift the focus on ecological issues ... thus disrupting this balance. It is suggested that the term "sustainable development" should replace the term "ecologically sustainable development".

R9. Sustainable development is used instead of ecologically sustainable development as suggested.

C9. Do not integrate figures that do not have any added value. The added value of each figure and its outcome should be described with sufficient detail. Please remove Figs. 9 and 10 or put it in the supplementary material.

R10. Some of the figures were removed and merge some to provide a valuable presentation into the research article.

C10. Although statement on ethical guidelines followed for this study is provided, the full name of the IRB/ethics committee that approved the study should be provided in the manuscript.

R11. Cape Peninsula University of Technology Centre for Postgraduate Applied Science Ethics Clearance Committee and Eskom Holdings SOC Ltd have provided ethics clearance letter to the researcher, respectively.

References

1. Bareki No. and Another v. Gencor Ltd and others. (2006). (1) SA 432 (T).
2. Barua A (2013) Methods for decision-making in survey questionnaires based on Likert scale. *J Asian Sci Res* 3(1):35–38
3. Baruch Y (1999) Response rate in academic studies-A comparative analysis. *Human Relat* 52(4):421–438
4. Baruch Y, Holtom BC (2008) Survey response rate levels and trends in organizational research. *Human Relat* 61(8):1139–1160
5. Bond AJ, Morrison-Saunders A (2009) Sustainability appraisal: jack of all trades, master of none? *Impact Assess Project Appraisal* 27(4):321–329
6. Boyd J (2002) Financial responsibility for environmental obligations: are bonding and assurance rules fulfilling their promise? In: *An introduction to the law and economics of environmental policy: issues in institutional design*, pp. 417–485. Emerald Group Publishing Limited
7. Brunnée J (2004) Of sense and sensibility: reflections on international liability regimes as tools for environmental protection. *Int Comparat Law Quart* 53(2):351–368
8. Burns PM, Novelli M (eds) (2008) *Tourism development: growth, myths, and inequalities*. CABI.
9. Butler T, McGovern D (2012) A conceptual model and IS framework for the design and adoption of environmental compliance management systems. *Inf Syst Front* 14(2):221–235
10. Calmeyer T, De Kok C, Hardy J, Rogers JA, Taljaard L (2011) How to succeed in your master's and doctoral studies: a South African guide and resource book, Johann Mouton: book review. *New Voices Psychol* 7(2):148–152
11. Chilwane SRM (2011) Life cycle management for power transformers in the Eskom distribution network-case study (Doctoral dissertation, University of Johannesburg)
12. Cooper DR, Schindler PS, Sun J (2006) *Business research methods*, vol 9. McGraw-Hill Irwin, New York
13. Dickson-Swift V, James EL, Kippen S, Liamputtong P (2007) Doing sensitive research: what challenges do qualitative researchers face? *Qualit Res* 7(3):327–353
14. Du Plooy GM (2009) *Communication research: techniques, methods and applications*. Juta and Company Ltd
15. Emmerly, M. (1993). An overview of sustainable development processes in Australia 1990–1992.
16. Eskom. (2016). 240–101385485 sustainability mapping at Eskom: Eskom's sustainable development framework. Climate Change and Sustainable Development. Eskom, Johannesburg
17. Field T (2006) Liability to remedy asbestos pollution: contaminated land—asbestos pollution—national environmental management act 1998—meaning of 'pollution'—duty to take

- reasonable measures—retrospective application of environmental legislation. *J Environ Law* 18(3):479–494
18. Flannelly LT, Flannelly KJ, Jankowski KR (2014) Independent, dependent, and other variables in healthcare and chaplaincy research. *J Health Care Chaplain* 20(4):161–170
 19. Ford L (2015) Sustainable development goals: all you need to know. *The guardian*, 19
 20. Free State (South Africa). (2015). Masilonyana local district municipal environmental management by-law. PN 182 in Free State Provincial Gazette 80 of 9 December 2011 and adopted by Free State Provincial Gazette 2 of 10 April 2015. https://discover.sabinet.co.za/inline_html?file=Free_State_Index.html Date of Access 14 Jan 2017
 21. Fuggle RF, Rabie MA (2009) Environmental management in South Africa. Juta and Company Ltd
 22. Gebers B (1998) The diversity of environmental agreements. In: *Co-operative environmental governance*, pp. 91–109. Springer, Dordrecht
 23. Gillham B (2000) Case study research methods. Bloomsbury Publishing.
 24. Harris JM (2003) Sustainability and sustainable development. *Int Soc Ecol Econ* 1(1):1–12
 25. Henning E, Van Rensburg W, Smit B (2004) Finding your way in qualitative research
 26. Holden E, Linnerud K (2007) The sustainable development area: satisfying basic needs and safeguarding ecological sustainability. *Sustain Dev* 15(3):174–187
 27. Holden E, Linnerud K, Banister D (2014) Sustainable development: our common future revisited. *Global Environ Change* 26:130–139
 28. Holden E, Linnerud K, Banister D, Schwanitz VJ, Wierling A (2017) The imperatives of sustainable development: needs, justice, limits. Routledge
 29. Hoy DR, Belisle FJ (1984) Environmental protection and economic development in Guatemala's western highlands. *J Dev Areas* 18(2):161–176
 30. Johnson RB, Christensen L (2008) Educational research: Quantitative, qualitative, and mixed approaches. SAGE Publications, Incorporated
 31. Johnson RB, Christensen L (2019) Educational research: Quantitative, qualitative, and mixed approaches. SAGE Publications, Incorporated
 32. Kotzé LJ (2007) The judiciary, the environmental right and the quest for sustainability in South Africa: a critical reflection. *Rev Eur Commun Int Environ Law* 16(3):298–311
 33. Kruger DJ (2003) Integrating quantitative and qualitative methods in community research. *Commun Psychol* 36:18–19
 34. Kumar R (2011) Research methodology: a step-by-step guide for beginners, 3rd edn. SAGE Publications Asia-Pacific Pte Ltd., London
 35. Kumar R (2014) Research methodology: a step-by step guide for beginners, 4th edn. SAGE Publications Asia-Pacific Pte Ltd., London
 36. Kumar R (2019) Research methodology: a step-by-step guide for beginners. Sage Publications Limited
 37. Lawrence DP (1997) PROFILE: integrating sustainability and environmental impact assessment. *Environ Manage* 21(1):23–42
 38. Leedy PD, Ormrod JE (2005) Practical research. Pearson Custom
 39. Leedy PD, Ormrod JE (2009) Practical research: planning and Design. Pearson, New Jersey
 40. Liguori SHERRY Protecting birds while powering America: an overview of efforts by the electric utility industry to reduce bird mortality and improve reliability. In: *Tundra to topics: connecting birds, habitats and people*. In: Proceedings of the 4th international partners in flight conference, pp13–16.
 41. Lune H, Berg BL (2016) Qualitative research methods for the social sciences. Pearson Higher Ed.
 42. Madalane T (2012) The obligation to rehabilitate mining areas: post mining activities (Doctoral dissertation, University of Limpopo (Turfloop Campus))
 43. Marshall MN (1996) Sampling for qualitative research. *Fam Pract* 13(6):522–526
 44. Mason M (2003) Civil liability for oil pollution damage: examining the evolving scope for environmental compensation in the international regime. *Marine Policy* 27(1):1–12
 45. Maxwell JA (2008) Designing a qualitative study. *The SAGE handbook of applied social research methods*, vol 2, pp 214–253
 46. Mortensen BOG (2001) The legal efficiency of voluntary environmental agreements illustrated by the EU electricity sector. *J Clean Product* 9(2):155–166
 47. Mouton J (2011) How to succeed in your masters and doctoral studies: A South African Guide and Resource Book. Van Schaik Publishers, Pretoria
 48. Newbery D (2008) South African Network Infrastructure Review (Doctoral dissertation, University of Cape Town)
 49. O'Neill R (2008) The advantages and disadvantages of qualitative and quantitative research methods
 50. Oyedepo SO (2012) On energy for sustainable development in Nigeria. *Renew Sustain Energy Rev* 16(5):2583–2598
 51. Paschke R, Glazewski J (2006) Ex post facto authorisation in South African environmental assessment legislation: a critical review. *Potchefstroom Electron Law J* 9(1).
 52. Preston B (2006) Sustainable development in the Courts in Australia and Asia. In Article for a seminar held at Buddle Findlay, Lawyers (Wellington New Zealand, 28 August 2006)
 53. Rabie MA, Blignaut PE, Fatti LP (1994) Mountains. In: Fuggle RF, Rabie MA (eds) *Environmental management in South Africa*. South Africa: Juta
 54. Richter BD, Mathews R, Harrison DL, Wigington R (2003) Ecologically sustainable water management: managing river flows for ecological integrity. *Ecol Appl* 13(1):206–224
 55. Rogner HH (2010) Nuclear power and sustainable development. *J Int Affairs*, pp 137–163
 56. Sax LJ, Gilmartin SK, Bryant AN (2003) Assessing response rates and nonresponse bias in web and article surveys. *Res High Educ* 44(4):409–432
 57. Silverman D (2013) Doing qualitative research: a practical handbook. SAGE Publications Limited
 58. South Africa (1996) The Constitution of the Republic of South Africa Act No. 108 of 1996. Government Notice No. 2083. Promulgation Dated: 18 December 1996. Commencement date: 4 February 1997. Government Gazette No. 17678
 59. South Africa. (1998a). National Environmental Management Act No.107 of 1998. Government Gazette No. 19519. 27 Nov
 60. South Africa. (1998b). National Veld and Forest Fire Act No.101 of 1998. Government Gazette No. 19515. 27 Nov.
 61. South Africa. (2004). National environmental management: air quality Act No. 39 of 2004. Government Gazette No. 27318. 24 Feb
 62. Spector BI, Sjöstedt G, Zartman IW (1994) Negotiating international regimes: lessons learned from the United Nations Conference on Environment and Development (UNCED). Graham & Trotman/Martinus Nijhoff.
 63. Styliou O (2015) Aspects on economic efficiency of the EU environmental liability regime
 64. Van der Linde M (Ed) (2006) Compendium of South African environmental legislation. PULP
 65. Vogt WP (1999) Dictionary for statistics & methodology: a ontechnical guide for the social sciences. Sage Publications Inc, Thousand Oaks
 66. Walliman N (2017) Research methods: the basics. Routledge.

67. Welman C, Kruger F, Mitchell B (2005) Research methodology. Oxford University Press Southern Africa (Pty) Ltd, Cape Town, pp 165–167
68. Wiggering H, Müller K, Werner A, Helming K (2003) The concept of multifunctionality in sustainable land development. In: Sustainable development of multifunctional landscapes. Springer, Berlin, pp 3–18
69. Winter G, Jans JH, Macrory R, Krämer L (2008) Weighing up the EC environmental liability directive. *J Environ Law* 20(2):163–191

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