A review of environmental monitoring and auditing in the context of risk: unveiling the extent of a confused relationship

Cláudia V. Viegas a,*, Alan Bond b,c,1, José Luís Duarte Ribeiro d,2, Paulo Maurício Selig a,3

a Engineering and Knowledge Management Department, Federal University of Santa Catarina (ECC/UFSC), Campus Universitário Reitor João David Ferreira Lima, Mail Box 476, Trindade, Florianópolis, Santa Catarina 88040970, Brazil
b School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK
c Department of Industrial and Transportation Engineering, Federal University of Rio Grande do Sul (DEPROT/UFRGS), Av. Osvaldo Aranha, 99 – 5th Floor, Porto Alegre, Rio Grande do Sul 90.035-190, Brazil
d School of Geo and Spatial Science, North-West University Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, South Africa

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A B S T R A C T

Monitoring and auditing are regarded as essential activities for process control and follow up, which contribute to improving performance in organizations and provide a key role in preventing or reducing environmental harm. However it is not unusual to find them confused with each other in the academic literature. This paper provides a detailed literature review of theoretical and review papers in order to clarify concepts and characteristics of environmental monitoring and auditing; and to suggest ways forward which can overcome this confusion. It was found that confusions stemmed from considerations of: similarities, hierarchy, overlaps, scope, risk issues and timeliness. The development of accounting and auditing over time was found to have led to a tendency of lack of direction in both monitoring and auditing and the disregard of adaptive management as originally understood in the impact assessment field. It is suggested that adaptive management, recovered from impact assessment and recent specific literature, can be applied to improve environmental monitoring and auditing.

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1. Introduction

Environmental monitoring and auditing are deemed essential procedures for organizations pursuing better control of their activities to avoid environmental harms (that is, it is inherently risk-based) or to bring positive impacts to the environment while getting a desirable performance towards economic and social assets involved in their business. In a broader sense, environmental monitoring is considered to be internal to an organizations’ scope and should address technical aspects of processes, such as operational controls (Pfaff and Sanchirico, 2000; Viladrich-Grau, 2003; Ramos et al., 2004; Kemp et al., 2012) or daily inspections through repetitive observation (Verschoor and Rejinders, 2001; Heyes, 2002) for facilities improvement (Mahwar et al., 1997; Stone, 2006).

Environmental auditing, usually seen as different, is defined as “a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organization, management and equipment are performing with the aim of helping to safeguard the environment by: (i) facilitating management control of environmental practices; and (ii) assessing compliance with company policies, which would include meeting regulatory requirements” (Moor and Beelde, 2005: 206).

At first sight, it is possible to assign an objective distinction between environmental monitoring and auditing, mainly due to the operational status of the former versus the managerial status of the latter. However, a detailed academic literature review on both terminologies – “environmental monitoring” and “environmental auditing” – reveals that these expressions are often used interchangeably (Colwill and Gray, 2007; Eckert and Eckert, 2010; Oliveira et al., 2011; Parmigiani et al., 2011) or overlapped (Spraakman, 2001; Evans, 2003; Ellis et al., 1996; Humphrey and Hadley, 2000; Gray, 2000; Toms, 2002; Hopkins, 2007; Cohen et al., 2008; Labadie, 2008). Humphrey (2008) warns about the tendency of lack of direction in both monitoring and auditing research. Another thread of confusion between monitoring and auditing comes from diversity of contexts in which they are...
applied: two in particular recur in literature reviews: accounting (Milne, 1996; Pruzan, 1998; Trotman et al., 2011) and impact assessment (Tomlinson and Atkinson, 1987; Thompson and Wilson, 1994; Ramos et al., 2004). Further confusion arises from the evolution in meaning of the terms over time in a single context.

Given the key role of ‘environmental monitoring’ and ‘environmental auditing’ in avoiding or managing environmental harm in a number of different fields, confusion over the meaning of the terms has the potential to hinder further development and learning. To this end, this paper seeks to clarify the nature of the confusion between the two terms, and to identify whether any opportunities exist for improving the ability of environmental monitoring and environmental auditing to reduce environmental harm.

This paper is structured as follows. Section 2 presents the methodological procedures based around a literature review. Section 3 presents the results in three parts: firstly depicting the main characteristics, roles and current criticism on environmental monitoring and auditing; secondly, categorizing the relationships between these concepts and practices; thirdly, shedding light on monitoring and auditing, and impact assessment, deemed as the foundations of confusion over the meaning of these terms. Final remarks are presented in Section 4.

2. Methodological procedures

A literature review was carried out using two databases, Web of Knowledge and Scopus, taking into account the whole content of both up to July 12th 2012. Three main searches were made using the “advanced search” feature and the Boolean operator “AND”. For the first search in Web of Knowledge, the expressions “environmental monitoring” AND “environmental auditing” were combined. This delivered 190 raw results, from which 79 were considered, after the exclusion of incomplete findings and articles not subject to peer review. For the second search also in Web of Knowledge, the expressions “environmental auditing” AND “environmental accounting” were submitted, and 90 references were found – from which 40 were kept after the exclusion of incomplete findings and documents not subject to peer review and after the elimination of redundant results. The third search, in Scopus, considered the expressions “environmental monitoring” AND “environmental auditing”, which delivered 1189 raw results. For practical reasons, further refining of the search was required to reduce the results to manageable proportions. This search was refined with the use of the expression “risk”, considering that risk issues, i.e. potential for harms of environmental, economic or social aspects of organizations, are of common concern for monitoring and auditing. Through this procedure 485 documents were identified. Incomplete references were eliminated, as well as references with no authorship details and those duplicated in the Web of Knowledge search. Analyzing in detail these 485 findings, the selection was refined to 161 papers by focusing on those whose abstracts contained at least the expressions – “environmental monitoring” and “environmental auditing” or “environmental monitoring” and “risk”, or “environmental auditing” and “risk”. The result of the three searches therefore delivered 280 papers: 79 from the first, 40 from the second, and 161 from the third.

To better underpin the theoretical foundations of the subject under analysis, an extra advanced search was carried out in Web of Science using the terms “environmental monitoring” AND “environmental auditing” AND “origins of”. It delivered 526 results, from which the first 100 were considered because the remainder were not significant in content or were repeated in previous searches. From these 100 results, 15 were deemed relevant to contextualize the issue. A further procedure was conducted in order to classify the results of all searches based on whether they referred to theoretical/review papers or applied studies.

For the purposes of this research, only the theoretical/review ones were considered, which comprised 90 results: 10 from the first retrieval, 18 from the second, 47 from the third, and 15 from the fourth. Another classification enabled the clustering of the theoretical papers regarding their subject: 18 are related to monitoring, 39 to auditing, 21 to accounting, and 12 are mixed – 7 focusing on monitoring and auditing, and 5 covering auditing and accounting.

The key findings of this study have been extracted from these theoretical/review papers as it has been assumed that these provide the basis either for consolidating the current thinking on the meaning of the terms ‘environmental monitoring’ and ‘environmental auditing’, or developing new directions.

The analysis of the literature is based on the authors’ interpretation of the papers extracted from the literature search coded into specific categories which are subsequently subjected to content analysis to identify and explain the relationship between environmental monitoring and environmental auditing. Such an approach is standard in qualitative interpretation of, interview transcripts and literature reviews (Burns, 2000), but the authors acknowledge that their own values and biases inevitably play a part both in the coding exercise and the content analysis. Whilst the sampling of literature is objectively conducted, the subsequent analysis is necessarily subjective and there is no certainty that other researchers would produce the same interpretation.

3. Results

Raw results of this research are presented in Table 1. Papers whose contents were considered for underpinning the characterization of environmental monitoring and auditing, as well as for outlining their respective relationship and/or for clarifying meanings, are highlighted in bold in Table 1. Authorship of the references used as the basis for Table 1 are depicted in Table 2.

3.1. Environmental monitoring and auditing: characteristics and criticism

The usual way of framing monitoring is based on its operational characteristics. Early literature regards environmental monitoring as actions performed to determine the links between causes and effects, in a chain, at regular time intervals, aimed at avoiding or tackling pollution (Russel and Landsberg, 1971; Keiser, 1975). Monitoring can be seen by some observers as surveillance, an almost unstructured repeated sequence of surveys or observations with the aim to detect change, but with no requirement to carry it out (e.g., Alexander, 2008). Monitoring is defined separately as mechanisms to demonstrate performance against commitments (Walton, 2000; Eckert and Eckert, 2010), control (Kelcey, 1986) and alerting observers when a system is deviating from the desired state (Legg and Nagy, 2006). The main attributes of monitoring, according to Verma et al. (2010), refer to the capability of capture, control and reporting a specific event while it occurs, maintaining its accuracy – closeness of analytical values to reference or standard values – and traceability – ability to replicate a sequence of measured values (Quevauviller, 2000). Risk avoidance is one of the central reasons for monitoring (Aintablian et al., 2007). However, studies applied to environmental analysis have shown, time after time, a relentless disregard of risk assessment in monitoring (Clement et al., 1991; Clement and Yang, 1997) and a tendency to focus monitoring on stringent procedural aspects such as sampling, extraction and calibration (Rubio and Perez-Benedito, 2009). Although the improvement of outward aspects of organizations – as a public relations exercise – is also mentioned as being
achievable through monitoring (Batzias and Lagodimos, 2008; Cormier et al., 2010), it is not always performed under legal requirements (Viegas et al., 2011).

Noticeably more structured, auditing was originally understood as a way of “hearing” (Packham, 1998), meaning the systematic and periodic review of management systems, policies or practices of corporations, institutions, governments, to assess how they affect the environment and suggest possible corrections (Thompson and Wilson, 1994). Some scholars refer to auditing as the second stage of monitoring (Heyes, 2002), which indicates a step further than simple compliance, towards management improvement (Birkmire et al., 2007). Power (1997) and Viladrich-Grau (2003) identify similarities between general and environmental auditing, emphasizing that science is on the mainstream of the latter, although subordinated to accounting procedures as part of a wide regulatory process. So, environmental auditing is also understood as an internal practice subject to external verification as in the case of voluntary or mandatory certification (Watson and Emery, 2004).

**Table 1**
Raw retrieved results of academic literature on monitoring, auditing and accounting.

<table>
<thead>
<tr>
<th>Subject Findings</th>
<th>1st search*</th>
<th>2nd search**</th>
<th>3rd search***</th>
<th>4th search****</th>
<th>Subject sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture/Farming/Veterinary</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Air Quality/Indoor environment</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Biomakers/Geomakers/Biotechnology/Biodiversity</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Building</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Climate/Meteorology</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>EIA/SEA</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Energy</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Fishing</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Forestry</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Food</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>GHG (greenhouse gases)</td>
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<td>0</td>
<td>3</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Health cleaning/hospital/exposure/occupational</td>
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<td>20</td>
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<td>27</td>
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<tr>
<td>Industry</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Information</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Landscape</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>11</td>
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<tr>
<td>Mining</td>
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<td>1</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Polluted land/Toxicology</td>
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<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Port/Airport/Railway</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Public policy/Planning</td>
<td>9</td>
<td>5</td>
<td>17</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Radioactivity/Nuclear</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
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<tr>
<td>Rivers/Beaches/Lakes</td>
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<td>0</td>
<td>3</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Soil</td>
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<td>0</td>
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<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Solid wastes</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Species (control/biodiversity/invasive)</td>
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<td>0</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Theoretical/Review papers</td>
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<td>18</td>
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<td>15</td>
<td>90</td>
</tr>
<tr>
<td>Tourism</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Water</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Papers sum</td>
<td>79</td>
<td>40</td>
<td>161</td>
<td>15</td>
<td>295</td>
</tr>
</tbody>
</table>

*Databases: Web of Knowledge, search terms: “environmental monitoring” AND “environmental auditing” = 79 valid results – July 12th 2012.** Database: Web of Knowledge, search terms: “environmental auditing” AND “environmental accounting” = 40 valid findings – July 13th 2012.*** Database: Scopus, search terms: “environmental monitoring” AND “environmental auditing” = 1189 results AND “environmental risks” = 161 valid results.**** Database: Web of Science, search terms: “environmental monitoring” AND “environmental auditing” AND “origins of” = 526 results, from which 15 were deemed relevant and not conflicting with previous searches. In all searches, papers were filtered by removing duplicates, with a final number of 167 results.

**Table 2**
Authorship of the theoretical references considered to develop the research.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Authors</th>
<th>Papers sum</th>
</tr>
</thead>
</table>
Evans (2003), recounting the history of auditing, states that it is mainly about the relationships between the companies’ owner and the stakeholders management, as a way of monitoring contracts, but she recognizes that audit assumes different meanings depending on the context in which it arises. It can be even considered as a managerial monitoring mechanism (Evans, 2003), Morrison-Saunders and Bailey (1999) posit environmental audits as bridges between impact assessment and management.

The usual understanding for environmental auditing is based on the way environmental aspects (Alin et al., 2010), resources (Sinclair-Desgagné and Gabel, 1997; Penini and Carmeli, 2010), or raw material and energy flows (Mahwar et al., 1997) are managed by organizations, driven by external demands (Pagano and Immordino, 2007). The existence of measurable standards is often highlighted as an essential attribute for auditing (Nikitin and Brooks, 1998; Humphrey and Hadley, 2000; Petroni, 2001; Balzarova and Castka, 2008). Rather than operational checks and control, auditing comprises issues of judgment and auditors’ opinions (Tomlinson and Atkinson, 1987) and behaviors (McMillan and White, 1993), and a social construction of, auditing, risk-oriented, is noticed as evolving in the environmental management field from the 80’s onwards (Power, 2003). Also in auditing there are considered the expectations of stakeholders (Evans, 2003; Sahnoun and Zarai, 2009), side by side with the level of expertise in performance (Houghton and Jubb, 1999). Recent research in auditing values interdisciplinary knowledge, in the realm of environmental and risk assessment (Humphrey, 2008) and relational capabilities in the sense of improving information sharing and stakeholders commitments (Pargmiani et al., 2011).

Sprakman (2001) compares internal auditing with a form of insurance, risk management and value adding to processes. He includes in internal auditing the appraisal of operations, as processes monitoring. Similarly, Knechel (2007) states risks assessment as being embedded in the original culture of auditing. With the evolution in this field, investigation of risks (Boiral and Gendron, 2011), aimed either at reduction, or understood as both threats and opportunities (Oliveira et al., 2011), became the cornerstone of auditing especially addressed to environmental issues. The targets of information disclosure and transparency, related to the governance aspects of management, are increasingly valued in environmental auditing (Whitford, 2008; Kolk and Perego, 2010; Kells, 2011). Nevertheless, effective risk abatement is generally not achieved through environmental auditing mainly due to implementation flaws (Ellis et al., 1996) and too little attention being paid to participative processes that could enable continuous learning (Penini and Carmeli, 2010). Regardless of the structural failures it presents, auditing comprises a mixed product of objective, explicit, and cognitive competences and it is deemed as strategic in the context of the overall performance assessment (Langfield-Smith, 2008).

Although no universally accepted definition of environmental auditing exists (Rika, 2009), it remains as a strong notion of an ongoing accepted concept in which a strategic overview, interdisciplinarity and risk assessment procedures are synchronized towards management improvement (Sinchuen and Ussahawanitchakit, 2009; Speklé et al., 2007) under the influence of dynamic knowledge tailored by the recent increase of professionalism in the field of environmental auditing (Tangpynioputtikhun and Thammavinyu, 2011).

### 3.2. Relationships between environmental monitoring and auditing

Supported by the literature review, it was possible to outline six types of relationship between environmental monitoring and auditing under which a significant amount of confusion can arise. This classification is described as follows:

- **Similarities**

  When operational and managerial aspects are indistinctly considered, a common meaning appears for monitoring and auditing: they are described to be the same, addressed to inspections (Eckert and Eckert, 2010) or to better management (Oliveira et al., 2011; Pargmiani et al., 2011), with no clear boundary to identify any difference. Another source of confusion in similarity comes from the idea of a continuum relationship, as stated by Colwill and Gray (2007). They refer to monitoring and auditing as complementary: the former related to compliance, and the latter to assurance; in this case the confusion arises because, while assurance is usually based on a standard (of environmental quality), outwardly known and shared, compliance refers to conformity that can embrace internal or external rules, mandatory or not, therefore comprising both monitoring and auditing procedures. Humphrey and Hadley (2000: 229) also consider that environmental auditing is “the monitoring of a company’s performance against previously agreed policy or statutory standards”. A third similarity is to refer to environmental monitoring or auditing as follow up for controlling processes or procedures – which is common in the cleaner production field or similar frameworks where informal arrangements prevail (Viegas et al., 2011). In the supply chain field, Pargmiani et al. (2011) deem monitoring capabilities as central skills that are performed throughout the auditing function, so that it is difficult to clearly distinguish one from another.

- **Hierarchy**

  The conception that monitoring exists within auditing (Birkmire et al., 2007; Savuc, 2007) serving to improve it (Batzius and Lagdimos, 2008) is widely accepted for those that frame monitoring within the operational field and auditing within the managerial field. So, a picture of auditing as more complex and structured than monitoring (Maletta and Kida, 1993) is easily drawn. If monitoring is deemed as fulfilling follow up commitments, conducted for internal purposes only, while auditing is mandated on regulatory pressures (Tomlinson and Atkinson, 1987), this reasoning is reinforced. There are several other ways to frame the same: to state that auditing is strategic (Sinclair-Desgagné and Gabel, 1997; Langfield-Smith, 2008) or that it is a more advanced stage of monitoring (Nikitin and Brooks, 1998). All these conceptions present monitoring as hierarchically subordinate to auditing. Nevertheless, other academic sources reverse this. Criticism about the lack of regulation for environmental auditing, making it discretionary (Boiral and Gendron, 2011), entail an inverse order in this relationship, and it can lead to ambiguity in respective meanings.

  Verschoor and Rejinders (2001), for instance, look to environmental monitoring as more comprehensive than environmental auditing while extending monitoring to business activities. In the impact assessment field also, it is common to find environmental audits referred to as part of the monitoring programs, aimed at process effectiveness (Thompson and Wilson, 1994; Morrison-Saunders and Bailey, 1999). In this field, monitoring is often conceived around the idea of adaptive management – a concept of the early 70’s coming from merged assumptions of ecology and environmental management fields, which indicates a flexible and participatory path for dealing with the complexity of ecological and human systems evolving together in, dynamic co-dependency (Armitage et al., 2008). In this sense, it is relatively difficult to indicate a hierarchic relationship between both practices due to flexibility and continuous rethinking of the processes. However, once monitoring is conceived in this context as an umbrella activity under which the management of the impacts is below scrutiny, the subordinated relationship cannot be dismissed.
Overlaps

Overlaps between environmental monitoring and environmental auditing could be identified as similarities, but they differ because whenever the meanings are superimposed, they can assume common or diverse aspects. Ellis et al. (1996), for instance, firstly consider environmental auditing systems aimed at the monitoring practices of environmental management in manufacturing, as monitoring embracing the whole system. Nevertheless, further on, they state monitoring as a localized activity, operational and proactive at the same time. And in the sequence, they move backwards referring to monitoring as an opportunity for learning in order to provide continuous advances in manufacturing. Gray (2000) advocates that there is not a clear terminology in the field of environmental auditing, which leads to alternate understanding. The overlaps become clearer while highlighting the argument that risk assessment and judgments are inherent to both monitoring and auditing (Hopkins, 2007). This apparent similarity in fact reveals a superposition. Studies related to internal auditing (Fadzil et al., 2005; Savcuc, 2007; Cohen et al., 2008), conceived as “independent, objective assurance and consulting activity designed to add value and improve an organization’s operations” (Labadie, 2008: 580), make it easy to become confused over the extent to which this type of auditing is really distinct from ordinary monitoring or to what extent they overlap. Other references regarding superposition are those which indicate some common features between operational monitoring and internal auditing (Sprakman, 2001; Speklé et al., 2007) and those which recover the origins of auditing. In this latter case, Evans (2003) shows that separation between the owner activities (risk embracing and control) and stakeholders responsibilities (management and decision) provides an opportunity for two-way monitoring, from one part to another, with different tools but with an eventual concurrent purpose, linked to liability and trust of the companies’ activities. Therefore in the roots of auditing, some monitoring routines can stand as concurrent.

Scope: internal vs. external

It is not difficult to differentiate the scope of monitoring and auditing once operational and managerial aspects are separately considered. Pfaff and Sanchirico (2000) and Kells (2011) argue that in monitoring data and information are recorded for internal use only, but in auditing their openness is essential due to the need to achieve transparency. The same is the case for internal and external auditing: “Internal audits are audits prepared for clients internal to the organization such as managers and boards; external audits are primarily prepared for external parties such as stockholders, governments, stakeholders, government agencies, banks, and so on” (Labadie, 2008: 502). Thus, under a wide understanding, scope would not be a matter of confusion for environmental monitoring and environmental auditing as well. However, a deeper look at the scope issue makes things somehow blurred. Because auditing takes place not just due to internal processes, but is also pushed by external questions that affect organizations, such as the costs of enforcement and compliance and incentives, it is argued that it avoids ambitious targets (Pagano and Immordino, 2007; Kells, 2011) and can lessen monitoring efforts as result. On the other hand, when internal audits are carried out with stringent controls, they can also produce the same effect — fading of monitoring (Fadzil et al., 2005). So, a careful analysis is needed about the extent to which the scope must be considered especially when environmental issues are at stake, because in this case the interfaces become more numerous than in single financial monitoring or auditing. Scope issues can trigger a dichotomous relationship between environmental monitoring and environmental auditing. It is especially noticeable when social and environmental disclosure are targeted in wide auditing with sustainability purposes (Rika, 2009).

Risk issues

Risk investigation, specifically aimed at risk reduction, is the cornerstone of auditing (Moor and Beelde, 2005; Verver, 2008; Alin et al., 2010; Boiral and Gendron, 2011). In monitoring, risk often represents an unintended troublesome issue, because timely data collection and registration does not give opportunities for further interpretation on risk, which depends on better designed indicators and on available time for assessment. Conversely, in auditing risk receives more attention under conformity standards (Kolk and Perego, 2010), although the focus on risk has been the subject of recent attention in auditing (Knechel, 2007), mainly while a socially constructed and strategic knowledge (Power, 2003; Sinchuen and Usahawanitchakit, 2009; Tangyinioputtikun and Thammavinuy, 2011). Nevertheless environmental risk being considered by auditors as relevant but disconnected from environmental auditing routines is not unusual, as identified by Alin et al. (2010). It mischaracterizes what environmental auditing is meant to be and poses environmental risk as an isolated subject of performance, under lack of qualitative analysis and theoretical basis. (Humphrey, 2008). So, under this disconnection, it is easy to misunderstand what is, monitoring and what is auditing when considering the treatment of environmental risk. The resurrection of adaptive management for ecological and human risk assessment somehow depicts a way back into the integration of risk monitoring with risk management (auditable) because it offers a participative and learning perspective to deal with uncertainties related to risk measurement and to causal relationships on risks also for organizational subjects: “Ecological risk assessment embodied in an adaptive management framework is becoming the global standard approach for formally assessing and managing the ecological risks of technology and development” (Gibbs, 2011: 1784).

Timeliness

The pace of environmental monitoring is usually regarded as faster than the pace of environmental auditing, mentioned as the second step of monitoring (Heyes, 2002). According to Strausz (2005), monitoring has a synchronic perspective; it takes place when the agent chooses his/her action and does not depend on additional information, while auditing occurs after the agent has taken the action. In monitoring, data to be checked out are generated in the process itself, while in auditing data are compared with a standard outside the process (Viegas et al., 2011). Therefore, environmental auditing is possibly a reflective action as opposed to environmental monitoring, where the timeframe is shorter (Russel and Landsberg, 1971). Viladrich-Grau (2003) considers auditing as long term monitoring. It suggests that timeliness is not at first a confused relationship regarding environmental, monitoring and environmental auditing. Unless multiple scales and/or multiple controlling stakeholders are embraced under the adoption of adaptive management principles (Cooney and Lang, 2007; Armitage et al., 2008; Eberhard et al., 2009; Karatzoglou and Spilanis, 2010), it is stated as a clear, uncontested relationship.

3.3. Auditing/accounting and impact assessment evolution: unraveling the foundations of confused meanings

It is possible to recover two main streams for understanding why monitoring and auditing are nowadays not related to each other in a simple way and why there are so many different
conceptions about their meanings and relationships (Thompson and Wilson, 1994). One stream is related to general auditing/accounting studies, which include the environmental management field regarding voluntary and mandatory certification systems (Power, 1997; Watson and Emery, 2004), and another one to environmental studies seen specifically through the lens of environmental impact assessment (EIA) given this is now identified as a formal decision-making tool in all but two countries in the world (Morgan, 2012). Both have been developed simultaneously and brought remarkable influences on how environmental monitoring and auditing are understood and used. “The term audit has been ‘transferred’ from the language of finance to environmental science, since it effectively portrays the concept of, examination and assessment of performance. In finance, the audit seeks to certify the activities against accepted accounting practices; while in EIA standards are poorly developed, only indicating general issues to be addressed” (Tomlinson and Atkinson, 1987: 188). It is therefore possible to suggest that financial accounting and impact assessment practices related to projects and their potential environmental harms were brought together and evolved to a plurality of contexts in which environmental monitoring and auditing have assumed a confused meaning. In this review, the whole theories behind EIA or accounting were not stressed. Rather the main insights that are supposed to clarify how the meaning of the terms “environmental monitoring” and “environmental auditing” became differently entrenched from each other and how they are detrimentally divorced from adaptive management principles were jointly captured.

3.3.1. Financial accounting/auditing thread and the slow pace of change

As Nicholls (2009) argues, three types of lens are available to filter mechanisms as auditing: the positivist lens — considers just empirical data reporting; the critical lens — focuses on control mechanisms assessment and liabilities issues (Feess, 1999); and the interpretative lens — opens the issue to discussion by stakeholders and the community and advocates the need for information disclosure (Auld and Gulbrandsen, 2010; Sutantoputra et al., 2012). Under the latter lens, governance has arisen as an increasing tendency (Short et al., 1999; Kent and Monem, 2008; Kent and Stewart, 2008; Rof and Danuletiu, 2010). An extensive development of the accounting tradition is also observed, settled in firms’ assets quantification (Alvarez et al., 2009) and in specialized work in which professionals responsible for accounting seek secure baselines and therefore choose to follow their own hypotheses on which to base their assessments (McMillan and White, 1993; Power, 1997, 2003; Knechel, 2007; Tharmavinvyu, 2011). Concerning financial accounting, it seems apparently far from influencing environmental issues, but historical development has shown disclosure of information and participation as key elements of accounting that have gradually come to embrace environmental aspects (Sprackman, 2001; Evans, 2003; Humphrey, 2008; Reverte, 2009; Kemp et al., 2012). “There is some support for the view that accounting disclosure is an important conduit for signaling facts about environmental management” (Toms, 2002: 276). In the next two subtopics we summarize how the evolution of financial auditing and accounting relates to the environmental facets of monitoring and auditing.

- Owner/stakeholder separation

Up to the beginning of the 90’s, accounting theory and application was a long way distant from the environmental issues (Rousse, 1992). Trotman et al. (2011) identify three main stages of development in this area: in the 70’s, financial accounting relied on information about the economic performance of firms; during the 80’s, it assumed a planning shape, aimed at preventing risks, which was similarly mentioned by Wallace (2004); from the 90’s onwards, it started to settle over the expertise paradigm and the awareness of risk as permanent, multiple-sourced and difficult to control. Sprackman (2001) and Evans (2003) attribute to the separation between owners and stakeholders roles the evolution of auditing to the stage of professionalism. While owners hold the risk taking role, stakeholders keep management and decision tasks, so monitoring and auditing functions could develop professionally in the hands of this second group. Until the early 90’s, auditing and accounting were deemed as optional for reducing environmental liabilities (Thompson and Wilson, 1994), although effectiveness was argued to depend on the quality of monitoring and auditing in impact assessment. A tendency for accounting to focus on ethical/human-based values rather than financial/control ones was noticed by Pruzan (1998) and Knechel (2007) from the middle 90’s onwards, and at the end of this decade, Lehman (1999) emphasized the need for less instrumentalized accounting which was closer to society’s needs. In the middle of the 90’s this type of criticism was already reported in academic literature by Milne (1996). Power (1997) advocated the need for an overlap composition between skills required for both financial and environmental accounting. According to him, introducing environmental concerns into auditing can be seen as re-management of the risks, a tendency developed from the last 15 to 10 years onwards.

- Knowledge expertise and risk treatment

Since the 2000’s decade, accounting research assumed the shape of a more pluralistic discipline, not detaching from, but going further on financial issues and quantitative approaches, as highlighted by Lee and Humphrey (2006: 184): “A number of field studies used qualitative techniques to explore how audits are socially constructed”. It opened the view for accounting as learning and strategically oriented (Labadie, 2008; Langfield-Smith, 2008), but “[we] know little about the development of auditing systems that emphasize learning, process improvement, motivation and deterrence” (Pennini and Carmeli, 2010: 53). It implies that environmental monitoring and auditing are somehow far from being processes addressed to effectiveness through best practices, lessons learned and better behavior in the sense of dissuading attitudes that can be environmentally harmful. As already stated by Power (1997: 142), “the field of environmental audit is one in which existing knowledge are both transferred and transformed, in which a new configuration of expertise is constructed by the realignment of a particular portfolio of competences”. What must be noticed is that, behind the advancement of a proclaimed more open and participative and less top down auditing and accounting initiative, old reasoning structures remain, and new mechanisms to support overture, participation and governance were in fact introduced in monitoring and auditing at a slow pace. It therefore resulted in confused conceptualization and applications for both environmental monitoring and auditing, while old and new paradigms for accounting continue to run in parallel.

3.3.2. Impact assessment thread and the inputs of adaptive management

There are a significant number of studies criticizing the poor effectiveness of environmental impact assessment (EIA). The recovering of some older and recent research in this area — Tomlinson and Atkinson (1987); Thompson and Wilson (1994); Bailey (1997); Morrison-Saunders and Bailey (1999); Ramos et al. (2004) — allows us to reinforce the contribution of impact assessment evolution in confusing environmental monitoring and
Environmental auditing. According to Tomlinson and Atkinson (1987), the search for accuracy in predictions has forced audit development in EIA, but it has not attained instrumentalization at earlier stages, and monitoring was subsequently referred to as follow up with commitments or stated as post-auditing activities (Dipper et al., 1998). Later on, Thompson and Wilson (1994) claimed audits as parts of wider monitoring programs in EIA, which inverted the usual logic of considering monitoring as operational processes, subordinate in hierarchy to auditing, usually considered as having a managerial role. In this context, monitoring was proposed to be regionally addressed, similarly to the under- operational ways of reasoning about control and follow up mechanisms for operations and management still blur the good distinction of both concepts and practices. Furthermore, impact assessment evolution was pointed out as another conflicted field serving to exacerbate an already unclear distinction. Because the impact assessment field has traditionally associated monitoring with the pursuit of effectiveness in EIA, it identified monitoring as an umbrella for auditing. In doing so, the impact assessment tradition left behind adaptive management, although originally conceived as one of their theoretical branches in the early 70’s. This introduced a significant gap through time for a more integrative understanding of environmental, monitoring and auditing as simultaneously associated with ecology and environmental, management fields.

Unraveling confused relationships between environmental monitoring and auditing could imply, at the first sight, the imposition of clear boundaries for both roles. Ordinarily, it is possible to keep framing monitoring as operational sets of procedures, focused on internal subjects of organizations, and auditing as managerially focussed, for organizational and interorganizational reasons. However, the awareness of adaptive management as one of the origins for monitoring, in the context of impact assessment of natural systems (as identified in the present research), and the development of adaptive management itself in diverse fields related to ecological and environmental management studies, opens the opportunity to also consider the adaptive management principles for improving both environmental monitoring and auditing especially for filling gaps between the operational and managerial aspects of organizations.

It is not proposed that adaptive management will provide a solution for all failures or inadequacies in environmental monitoring and auditing. Rather, it is suggested that the adaptive management set of principles: flexibility, consideration of uncertainties, participatory overt and continuous learning, are appropriate characteristics to be embedded in environmental monitoring and auditing, and could enhance their connection.

It must be highlighted that impact assessment, as just one source of adaptive management, is applied to both natural and man-made projects (organizations). Because impact assessment relates to the interfaces of natural and anthropogenic environments, adaptive management principles also can be related to the relationships between environmental monitoring and auditing for harnessing one to each other. This is nevertheless a missing insight in industrial engineering systems where monitoring and auditing are usually confounded. The input of adaptive management in this context is considered worthy mainly due it comprehensiveness in the integration of processes, operations and concerned people.

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