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Editorial Note

The first issue of the first volume of SAJMR received good response from the readers. The feedback received from the readers made us to improve the present issue.

The present issue has broader scope than the earlier, yet we have kept the true spirit of the journal. In this issue we have included articles from the Computer Studies and Environmental Management field as well. As we have stated earlier, the objective of the journal is to provide a common platform for the practicing managers and academicians to share their research knowledge through this journal.

In future, we also welcome articles related to different pedagogical approach in management teaching. Many courses including management discipline everywhere use more of a traditional approach of lecturing to share the knowledge. Lecturing method is more passive in nature. Case study comes next to lecturing method in imparting knowledge. But not much has been done in developing experiential approach as a pedagogy of teaching in management field, particularly in India.

Experiential learning is more active rather than passive. The readers can contribute case studies and teaching material in experiential learning approach in different management fields such as marketing, human resources, organization behaviour, organizational change and development, strategic management, etc.

I am grateful to all the authors, reviewers and editorial members of the journal for their contribution and support in bringing out the second issue of first volume of the journal successfully.

Dr. Babu Thomas
Editor

Confluence of Corporate Social Responsibility (CSR) and Strategic Management: A Review

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Abstract
In the domain of Corporate Social Responsibility (CSR) this era is the era of doing CSR which has Strategic significance for a firm. In the decade of the 1960s advocacy on CSR began and through the 1970s and 1980s the CSR momentum gained strength. It was only in the 1990s that CSR found widespread space in practice. From the beginning of this millennium the notion of securing business benefits from doing CSR activities, that is Strategic CSR, gained momentum. This article provides the literature review on the various themes where in CSR literature touched Strategic Management literature and vise versa.

Keywords: Corporate Social Responsibility (CSR), Strategic Management

1. Introduction

The integration of CSR at the firm's strategic management level is very essential. The study of CSR keeping the context of firm strategy is important for having a holistic understanding and approach to CSR management of firm. The study of CSR with firm strategy has been a comparatively new theme of enquiry. Strategy is an amalgamation and integration of the various disciplines of management.

The early days of strategic management were based on the studies done on the domain of 'General Management'. Andrews (1971) undertook largely descriptive case based studies on firms from a holistic business perspective. Ansoff (1977) provided for prescriptive approaches in strategic management literature. One of the most central research questions in strategic management literature has been; firstly, why do some firms outperform others? And secondly why do such inter firm performance differences continue for a period (Bain, 1959)? Thus, can CSR form the basis of such firm benefits needed to be discussed?

Some researchers found that strategy had its roots in military world. Literature on military strategy like 'The Art of War' by Sun Tzu, 'On War' by von Clausewitz and 'The Red Book' by Mao-Tse Tung provided the base for such deliberations. All these books emphasized on separate themes. The tactical/ operational side of strategy was highlighted by Sun Tzu. The work of Von Clausewitz taught the unpredictable and dynamic nature of strategy while guerrilla strategy perspective was provided by Mao-Tse Tung. If strategy is war like (competitive attempts to establish firm interests), then on the face of it one can argue that, CSR seems antagonistic to strategy. CSR is based on the all emancipating philosophy of taking care of the needy stakeholders. CSR has a place in the heart of the organizations while strategy has roots in the minds of the organization.

2. Traditional CSR and its discontent with strategy

CSR stands for taking care of the stakeholders in an ethical and moral manner (Hopkins, 2003). According to the great scholar Carroll (1979) CSR is basically, businesses fulfilling four main responsibilities: economic, legal, ethical, and philanthropic.

Traditional CSR has generally meant and as has been frequently evident, stands for

- social work unrelated to business and
- widespread social programs, directed to almost all and any social or environmental issue.

Traditional CSR represents a pure philanthropic approach wherein firms undertake charity or give donations to some community or some stakeholder without expecting any benefit. From the very beginning of the concept of CSR, when firms started indulging in philanthropic

and charitable activities, scholars and researchers had advised organizations to restrain from such pure philanthropic social activities (Levitt, 1958). Society is filled with a multitude of problems varying in magnitude and type and business would do no good to itself, by indulging in addressing the entire gamut of social issues (Drucker, 2001; Porter and Kramer, 2006). If a cement manufacturing firm builds village infrastructure (through the use of its cement) then the CSR is related to its business but if the same cement manufacturing firm sponsors a local sports tournament then it is not a case of a related CSR activity.

Porter and Kramer (2006) had advocated that business shouldn't attempt to solve all the societal and environmental problems (CSR initiatives which are not related to business activities) as business don't have the resources, expertise, competence and the necessary relevant skills to solve social and environmental problems. So, firms should do CSR activities related to its core business as unrelated CSR activities undertaken by firms might be ineffective and inefficient (Drucker, 2001).

Levitt (1958) had admonished that if business starts addressing all social issues then not only will it engineer inappropriate solutions to social problems but overtime business firms would gain unprecedented power. This would have not just economic but social, political and cultural fallouts in the society. Further, business firms can lose their main existential institutional focus of creating wealth for their shareholders (Levitt, 1958). Such CSR activities, addressing many and wide range of social and environmental issues, might end up in wasting shareholder wealth, firm resources and the management's valuable time (Friedman, 1970; Porter and Kramer, 2006). Also, business firms are too small an entity to address, tackle and manage the mammoth social challenges (Porter and Kramer, 2006). Further, social problems might not get solved properly (Porter and Kramer, 2006). Friedman (1970) argued that businesses pay taxes to the government and it is the responsibility of the government to take responsibility of the problems that society faces. The responsibility of business is limited only to the extent of paying taxes. Not surprisingly then, researchers found, over the years, that, traditional firm's philanthropic activities and social initiatives have not been a dominant objective in the corporate goal hierarchy (Mintzberg, 1983). CSR has often been treated as a neglected activity (Trainer, 2005) because non-strategic CSR could be very valuable to the society and other stakeholders but such CSR initiative does not necessarily do much good to the firm (Burke and Logsdon, 1996; Porter and Kramer, 2006) and take a back seat in management action. One can argue that superficially the stakeholder theory may justify unrelated CSR but as, the works of the researchers mentioned point out, unrelated CSR though may do good for some stakeholders, but in the long run it is bad for both the firm and the stakeholders.

A successful and sustainable CSR programme must be inextricably linked with the core business as bottom-line ultimately counts. Hence, CSR must stay close to business (Collins, 2003) and benefit the economics of the firm (Bruch, 2005; Porter and Kramer, 2002). If CSR does not benefit a firm, it is not supposed to be sustainable in the long term (Bruch, 2005; Porter and Kramer, 2006).

3. What is Strategic CSR?

If traditional CSR is not the best thing to do for a firm then what type of CSR should a firm undertake? The dissatisfaction and demerits of traditional CSR led to the genesis of Strategic CSR. It is therefore important to have a good understanding of strategy and CSR. In this section, CSR is discussed with the various theories of strategic management literature. Many agree that it is has been difficult to present a standard single point explanation of what is strategy? (Miller, 1998; Porter, 1996). Various explanations and reflections of the concept of strategy provide varying shades of themes. Strategy seemed to be related with doing and offering something unique, something that others could not offer (Porter, 1996). Strategy can also be viewed as a firm's own path setting, on how it is going to gain Sustained competitive advantage (SCA), not just temporary competitive advantage (CA) (Miller, 1998). The importance of SCA over CA has to be understood. It is not enough just to gain competitive advantage as competitors can over a period of time, gain similar strengths that the

firm was providing in the first place. Such CA can get eroded and the advantageous position could be lost (Miller, 1998). So when a firm creates a CA situation then it has to be sustained over a reasonable period of time so that other competing firms do not gain the advantageous positions (Miller, 1998). This is the notion of SCA-CA that lasts for a reasonably long time. CSR strategies, when supported by political strategies, can be used to create SCA (McWilliams *et al.*, 2002). Which type of CSR activities can provide SCA need to be delved into further? For certain companies, environmental social responsibility can also constitute a resource or capability that leads to a SCA (Hart, 1995). Since the 1990s, there is an increased emphasis on aligning the philanthropic activities with the business goals (McAlister and Ferrell, 2002; Smith, 1994) and it is expected to grow in the years ahead (Lantos, 2001).

Strategic CSR is seen as a profit-maximizing strategy with the basic social responsibility dimension (Bagnoli and Watts, 2003). According to Lantos (2001) strategic CSR is "Good for business as well as good for society". Porter and Kramer (2006) viewed strategic CSR as those CSR activities which benefit the society as well as bring substantial benefits to the firm. Strategic CSR is selective as it integrates both the social cause and the business case, while non strategic CSR does not. Out of the many social and environmental causes only few offer the opportunities of seeking competitive advantage. Porter and Kramer (2006) were of the opinion that Strategic CSR is more than just mitigation of the harmful value chain impacts or just indulging in some social work here and there, now and then. It is integration of the social initiatives into the firm's business context to generate substantial and distinctive business benefits. Burke and Logsdon (1996) wrote that a CSR policy, programme or process is strategic when it brings substantial business-related benefits to the firm. Strategic CSR supports core business activities and thus contributes in enhancing the firm's effectiveness in accomplishing its mission and goals. In strategic CSR, stakeholders or entities outside the stockholder group are viewed as means to the ends for maximizing shareholder wealth (Goodpaster, 1996). Baron (2001) viewed strategic CSR as the use of CSR to attract socially responsible consumers. Thus, strategic CSR has the sense that firms provide a public good in conjunction with their marketing/business strategy (Baron, 2001). Strategic CSR is based upon the same professional management principles as applied to any mainstream business operations. Managers have to first set the social context of CSR by listening and deciding on the social issues to address. Then firms have to align firm's social initiatives, keeping in mind the firm core competencies and leverage the firms unique capabilities to benefit society (Bruch, 2005). Strategic CSR integrates both the firm's internal and external perspective (McAlister and Ferrell, 2002). Strategic CSR is undertaken to accomplish strategic business goals as well as to be good for society (Carroll, 2001). With strategic CSR, corporations "give back" to their constituencies because they believe it to be in their best financial interests to do so. Strategic CSR calls for deriving business sense from CSR (Mitra, 2006) or secure the business case for sustainability (BCS). Salzmann *et al.* (2005) explained Business Case for sustainability (BCS) as a means of addressing social and environmental concerns because of organization's primary and secondary activities. Thus BCS is linked to the firm's strategy which is profit-driven. The notion of CSR as an opportunity rather than a cost was also seen as Corporate Social Opportunity (Grayson and Hodges, 2004). Social Entrepreneurship extends strategic CSR beyond just profit maximization and market value creation (Baron, 2007).

Ricks (2005) observed that in the last decade or so the 'business case' for CSR activities has gained considerable momentum. As previously discussed, the notion that CSR should benefit organizations is no news now. The question is all about which CSR activities organizations should undertake to gain benefits. The answer to this question is present in the domain of Strategic CSR.

In traditionally benevolent or charitably oriented philanthropic activities, resources such as cash, as a percentage of total sales are donated for social causes. But in the strategic philanthropy benefits to both the organization and the society have to be achieved. Ricks (2005) has defined strategic corporate philanthropy as a firm's voluntary action to use firm's resources for social and environmental

causes that also help the firm to achieve its marketing or other business related objectives. It is, therefore, implied that firms seize opportunities on the social and environmental fronts (altruistic preferences) by involving in strategic CSR which utilizes market opportunities and improves profits (Baron, 2001).

For strategic social initiatives McAlister and Ferrell (2002) emphasized that there should be proper understanding of employees' needs and their core skills. Further, the firm's financial and other resources (including knowledge base and expertise) have to be mapped. Last but not the least, the employees, customers and suppliers and societal needs have to be linked with the resource base and competencies of the organization.

More specifically Strategic CSR is a way of seeking competitive advantage in the targeted product market of the firm. When a firm provides for a public good (by means of environmentally friendly or socially responsible activities) it becomes a by-product of product-market competition between firms (Bagnoli and Watts, 2003). The notion of Competitive advantage (CA) is of central importance for a firm. Competitive advantage is gained by a firm when it creates more economic value than its competitors. According to Porter (1985), a firm should offer its products and services at a lower price than its competitors or offer goods and services of better (different) quality. Miles and Covin (2000) had advocated that CSR to be strategic should provide cost leadership or differentiate firm's products. Porter and Kramer (2006) wrote that firms to have strategic CSR have to reach a unique position by attending cost leadership or product differentiation position to serve the customers better. The authors cautioned that for undertaking Strategic CSR a substantial portion of corporate resources has to be dedicated and management attention had to be provided. McWilliams and Siegel (2001) called firms to engage in CSR activities with such stakeholders for which customers (or someone else) are prepared to pay. Bhattacharyya *et al.* (2007; 2008) pointed out that Strategic CSR not only helps it to achieve generic strategies like cost leadership and product differentiation but also helps a firm to minimize social, political and economic risks.

Reiterating the dissatisfaction Friedman had with traditional CSR because of the lack of logical rigour and the substantive ambiguity present in ethically driven CSR (also Jones, 1995) Basu and Guido (2005) delved little further into the dichotomy of CSR as altruistic or strategic. They suggested that the CSR engagement of a corporation is of four types. They viewed CSR to be on/off value or on/off strategy. The normative/deontological foundation of CSR talks about the ethical aspects of doing CSR, which is the value dimension of CSR. While the instrumental/teleological foundation of CSR talks about the benefits of doing CSR with stakeholders, which is the strategy dimension of CSR. These two types of CSR are theoretically independent of each other (Basu and Guido, 2005).

This brings the discussion to the realization that there are conflicting pressures for CSR. It should therefore be a balancing act between business (economic) benefits, ethical performance, and social performance, amongst various stakeholders (Lantos, 2001). One of the most extreme positions on the lack of rigor of CSR based on the normative school was taken by Carr (1996), who believed that the only motive of business is to earn profit by producing and selling a product. So, he saw the prevalence of a competitive atmosphere. But this is a weak argument as stakeholder theory puts the firm at the center of various stakeholders not just as only one to one relationship between the firm and the shareholder as Carr (1996) believed. According to Windsor (2006) a firm's social initiatives, viewed from an instrumental theory perspective are philanthropy in disguise. Firm managers use the firm's discretionary powers to secure benefits for it, apparently dominantly benefiting society and its causes.

The competing contest in CSR on the moral base and the business case can be stressed to the two dominant stakeholder ideologies, instrumental stakeholder theory and normative stakeholder theory. This has been discussed in the next section.

4. Instrumental stakeholder theory and normative theory

Actually, two dominant stakeholder ideologies, instrumental stakeholder theory and normative

stakeholder theory, provided impetus to the philosophy of CSR (Donaldson and Preston, 1995). Normative stakeholder theory expected that firms should do CSR because it is ethically correct (Donaldson and Preston, 1995). It is in line with values and norms of the society. In normative stakeholder theory both the nature of achievement of business goals (ends) as well as how business achieves it (means) are important. Normative stakeholder theory expects that such CSR pays off in terms of positive financial returns to a corporation in the long term. Instrumental stakeholder theory, on the other hand believes that a firm undertakes only those CSR activities which can bring benefits to the business (Donaldson and Preston, 1995). Ends are more important than means or in other words ends can justify the means. In the instrumental ideology, CSR is viewed as an investment, providing either a direct financial return or indirect benefits to the firm (Kaler, 2003). But there are critics of the instrumental ideology (Matten and Crane, 2005; Swanson, 1999; Walsh *et al.* 2003). They argue that CSR has its root in the normative theory (in norms, morals and values). There has also been substantial uncertainty and skepticism about the concept of BCS or strategic CSR (Walley and Whitehead, 1994). Barnett (2007) wrote that to justify the business case for CSR is similar to the ambiguity in justification for investments for generation of other intangible assets like in R&D or in advertising. CSR investments debate, on its prudence on getting return is not new. CSR is a necessity for the existence of business firms in society and thus Barnett (2007) had advocated for a contingency perspective on CSR. Valor (2007) used the twin theories of CSR and moral capital theory to conceptualize a global strategic model for Corporate Philanthropy (CP). Similarly, Maignan *et al.* (1999) had conceptualized CSR as collaboration between internal and external stakeholders rather than an opportunistic act of investment.

Thus, Bruch (2005) also wrote that a firm's social initiatives rest mainly on two schools of thoughts, market orientation and competence orientation, but he had put it in a different angle. The Market Oriented firm CSR philosophy emphasizes on giving attention to important stakeholders like customers, local communities, employees and government agencies. The focus is an externally oriented one; so that the firm's competitive position is improved in the industry. The Competence Orientation, on the other hand, looks inside the firm. In this orientation, the firm's level of social initiatives are so designed that they are tuned to the firm's abilities and core competencies to create unique value proposition for the firm. This is business related CSR as advocated by Drucker (2001). It saves the firm from situations in which the firm is distracted from its core business because of undertaking unrelated CSR. Bruch (2005) advocated carrying out related CSR, because he believed that it was one of the most efficient ways of doing CSR. Thus some researchers have talked about the coexistence of both instrumental and normative stakeholder theories.

5. Theoretical underpinnings on Strategic CSR from Strategic Management Theories

To have a better understanding of Strategic CSR it is indeed worth an effort to briefly discuss strategic CSR in perspective to the various Strategic Management Theories. Let us start our discussion with the 'Resource Based View (RBV)' (Barney, 1991; Penrose, 1959; Wernerfelt, 1984). The differences in performance between two firms can be attributed because of the possession of different resources, skills and capabilities as well as the different way of managing the possessed resources, skills and capabilities by different firms. The key assumptions in this are of 'Resource heterogeneity'. Competing firms may control different resources and capabilities (Mahoney and Pandian, 1992) and these differences may last long periods of time. Organizations should attempt to generate Strategic resources thought the firm level CSR activities. 'Valuable, Rare, Inimitable and Non Substitutable (VRIN)' resources can provide firms competitive advantage (Barney, 1991; Dierickx and Cool, 1989; Wernerfelt, 1984). These resources can not be gained easily by a competing firm, so the advantage (in terms of superior economic rents that a firm can derive from the consumer market) can not be achieved by other firms. Thus the firm should generate strategic resources through CSR activities (Litz, 1996) to have SCA. Thus CSR managers should plan their CSR activities such that thus generate strategic resources (Branco and Rodrigues, 2006; Russo and Fouts, 1997).

Any firm is dependent upon certain type of resources to produce its goods and services to harness rent from the market. Certain firm resource inputs are so important for a firm that it is important that the firm can continue to get the rent. It thus becomes imperative for a firm to secure the supply of such raw material. From the perspective of 'Resource Dependency Theory' (Pfeffer 1982; Pfeffer and Salancik, 1978; Salancik 1979; Scott 2003), firms should try to secure these resources by undertaking the firm CSR activities. Securing such resources (on which the firm depends such as raw materials) would help the firm to run the core business (Brooks, 2005) and further have a buffer of such resources for the not so sunny days. From a 'Transaction Cost Economics theory' (Coase, 1937; 1960; Williamson, 1981; 1985) perspective, firm CSR activities can be designed such that it reduces the cost of transaction interaction between the firm and the various stakeholders with which the firm interacts and have a relationship in society (Brooks, 2005). The reduction in the transaction costs would provide the firm advantages over the competitors. From the 'Agency Theory 'perspective, a firm can be managed by managers in such a fashion that its CSR is indicative of non self-serving behaviour on the part of managers, and thus, reduces shareholder wealth (Friedman, 1970) but at the same time CSR can be seen as a way of creating stakeholder wealth, from which shareholder's can benefit.

In terms of the 'Dynamic Capabilities Model' (Teece *et al.* 1997), organizations redistribute, rearrange and reconfigure its resource base and capabilities to suit the dynamic environment. CSR can be undertaken both to enhance (and or build) the quantity and quality of resources (and capabilities) so as to address the changing environment and stakeholders expectations. CSR initiatives can help organizations to adapt to the environmental demands better (Brooks, 2005). Similar to this from the Industrial organization theory (Bain, 1959; Porter, 1980) perspective, if one takes Porter's five forces model as a base, then CSR activities should reduce the supplier bargaining power by securing input resources. CSR should help to innovate to reduce the threat of substitute or new products. This line of thinking also gets justification in the Dynamic Capabilities Model, wherein innovation by means of CSR could help in dealing with the changing environment in a superior manner and reach SCA from CA. CSR can be done to modify or sophisticate the buyers' demand. This could help in the reduction of buyer power if simultaneously the firm could provide the products for which the demand was created and is the only firm providing the products. Further firms can by their CSR initiatives, achieve the social license to operate or enhance operational efficiency to fight inter firm rivalry. Thus Strategic CSR is congruent to most of the theories of strategic management.

Reinhardt (1998) wrote that a firm engaging in a strategic CSR based approach can only generate an abnormal return if it can prevent competitors from imitating its strategy that is to maintain its unique position. But more interestingly, recent economic models on CSR (Baron, 2001; Fedderson and Gilligan, 2001) observed an important countervailing force in oligopolistic industries, for firms engaging in strategic CSR. Based upon the example of the attack on Nike's Asian production (or other leading firms) by social activists it was hypothesized that it is difficult for oligopolistic firms to achieve the state of competitive advantage through Strategic CSR. The countervailing argument to this can be that the CSR can be so designed that it is transparent with no room for ambiguity (Baron, 2001; Fedderson and Gilligan, 2001).

6. Future Research Agendas

This article amalgamated various literary themes from theoretical CSR with the classical strategic management literature. Researchers are developing frameworks for practicing managers for designing and implementing Strategic CSR activities (Bhattacharyya *et al.* 2007; 2008). It should be the way forward as the theoretical literature on Strategic CSR should make way for practice based perspectives. Future researchers can undertake empirical studies to establish the relevance and importance of Strategic CSR. Such future studies could also indicate the challenges one faces in implementing Strategic CSR initiatives, especially in India culture where CSR stands for something intrinsically good. But given the competitive pressures which a modern corporation faces, Strategic CSR is the way forward not CSR.

References

Andrews, K.R. (1971) The Concept of Corporate Strategy, Dow-Jones Irwin, Homewood, IL.

Ansoff, H. I. (1977) Managing surprise and discontinuity: strategic response to weak signals, In H. B. Thorelli (ed.), (1977) Strategy Plus Structure Equals Performance, Indiana University Press, Bloomington, IN, pp. 53-82.

Bagnoli, M. and Watts, S. G. (2003) Selling to Socially Responsible Consumers: Competition and the Private Provision of Public Goods. *Journal of Economics & Management Strategy*, 12 (3): 419–445.

Bain, J, S. (1959*). Industrial organization,* New York, John Wiley.

Barnett, M.L. (2007) Stakeholder influence capacity and the variability of financial returns to corporate returns to corporate social responsibility, *Academy of Management Review,* 32(3): 794-816.

Barney, J.B. (1991) Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1): 99-120.

Baron, D.P. (2007) Managerial Contracting and Corporate Social Responsibility. *Journal of Public Economics*.

Baron, D. (2001) Private Politics, Corporate Social Responsibility and Integrated Strategy. *Journal of Economics and Management Strategy* 10: 7–45.

Basu, K. and Guido, P. (2005) *An Inductive Typology of Corporate Social Responsibility*, Best paper proceedings of the Annual Meeting of the Academy of Management Conference.

Bhattacharyya S.S., Sahay, A., Arora, Ashok Pratap and Chaturvedi, Abha (2008) A toolkit for designing firm level Strategic Corporate Social Responsibility (CSR) initiatives *Social Responsibility Journal (SRJ)* 4(3): 265-282.

Bhattacharyya S.S., Sahay, A., Arora, Ashok Pratap and Chaturvedi, Abha (2007) Development of a CSR-Strategy-Framework, The Corporate Responsibility Research Conference (CRRC), 15-17 July 2007, Devonshire Hall, University of Leeds, Leeds, United Kingdom.

Branco, M. and Rodrigues, L. (2006) Corporate Social Responsibility and Resource-Based Perspectives. *Journal of Business Ethics, Dordrecht,* 69(2): 111-132.

Brooks, S. (2005) Corporate social responsibility and strategic management: the prospects for converging discourses *Strategic Change* 14(7): 401-411.

Bruch, Heike (2005) The Keys to Rethinking Corporate Philanthropy, *MIT Sloan Management Review* 47(1): 49-59.

Bruch, H. (2005) The Keys to Rethinking Corporate Philanthropy *MIT Sloan Management Review* 47(1): 49-59.

Burke, Lee and Logsdon, Jeanne M. (1996) Corporate Social Responsibility - Pays Off. *Long Range Planning*, 29(4): 437-596.

Carr, A.Z. (1996) Is business bluffing ethical? In: Rae, S.B., Wong, K.L. (Eds), *Beyond Integrity: A Judeo-Christian Approach*, Zondervan Publishing House, Grand Rapids, MI, pp. 55-62.

Carroll, A.B. (1979) A Three-Dimensional Conceptual Model of Corporate Performance *Academy of Management Review* 4(4): 497–505.

Coase, R.H. (1960) The problem of social cost *Journal of Law and Economics* 3: 1-44.

Coase, R.H. (1937) The nature of the firm *Economica* 4: 386.

Collins, Rebecca (2003) Behind the brand is business social responsibility. *Consumer Policy Review* 13(5): 159-165.

Dierickx, I. and Cool, K. (1989) Asset Stock Accumulation and Sustainability of Competitive Advantage. *Management Science* 35(12): 1504-1511.

Donaldson, T. and Preston, L. (1995) The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. *Academy of Management Review* 20(1): 65-91.

Drucker, P.F. (2001) *Social impacts and social problems - The Essential Drucker*, Butterworth Heinemann Publication: Oxford.

Feddersen, T. and Gilligan, T. (2001) Saints and markets: activists and the supply of credence goods *Journal of Economics and Management Strategy* 10: 149–171.

Friedman, M. (1970) *The social responsibility of business is to increase its profits*. New York Times Magazine, 13 September, 32–33, 122, 124, 126.

Goodpaster, K.E. (1996) Business ethics and stakeholder analysis. In: Rae, S.B., Wong, K.L. (Eds.), *Beyond Integrity: A Judeo-Christian Approach*, Grand Rapids, MI: Zondervan Publishing House, pp. 246-254.

Grayson, D. and Hodges, A. (2004) *Corporate Social Opportunity 7 steps to make Corporate Social Responsibility work for your business Introduction*, Sheffield: Greenleaf Publishing Limited.

Hart, S.L. (1995) A natural-resource-based view of the firm. *Academy of Management Review* 20(4): 986–1014.

Hopkins, M. (2003) *The Planetary Bargain Corporate Social Responsibility Matters*, Why Corporate Social Responsibility, Earth Scan, London.

Jones, M.T. (2005) The Transnational Corporation, Corporate Social Responsibility and the 'Outsourcing' Debate *The Journal of American Academy of Business,* 2: 91-97.

Kaler, J. (2003) Differentiating stakeholder theories *Journal of Business Ethics, Dordrecht* 46(1): 71-83.

Lantos, P.G. (2001) The boundaries of strategic corporate social responsibility *Journal of Consumer Marketing* 18(7): 595-632.

Levitt, T. (1958) The Dangers of Social Responsibility. *Harvard Business Review* 36: 41-50.

Litz, R.A. (1996) A resource Based View of the socially responsible firm; stakeholder interdependance, ethical awareness and issue responsiveness as strategic asset. *Journal of Business Ethics; Dordrecht*: 15(12): 1355-1364.

Mahoney, J.T. and Pandian, J.R. (1992) The Resource-Based View Within the Conversation of Strategic Management. *Strategic Management Journal* 15(5): 363-380.

Maignan, I., Ferrell, O.C. and Hult, G.T.M. (1999) Corporate citizenship: cultural antecedents and business benefits. *Journal of the Academy of Marketing Science* 27(4): 455-469.

Matten, D. and Crane, A. (2005) Corporate Citizenship: Toward An Extended Theoretical Conceptualization *Academy of Management Review* 30(1): 166-179.
McAlister, D. and Ferrell, L. (2002) The role of strategic corporate philanthropy in marketing strategy *European Journal of Marketing* 36(5): 689-708.
McWilliams, A. and Siegel, D. (2001) Corporate social responsibility: A theory of the firm perspective. *Academy of Management Review* 26: 117–127.
Miles, M.P. and Covin, J.G. (2000) Environmental marketing: A source of reputational, competitive, and financial advantage *Journal of Business Ethics* 23(3): 299–311.
Miller, A. (1998) *Strategic management*. Irwin McGraw-Hill, Boston, 3rd ed.
Mintzberg, H. (1983) The case for corporate social responsibility *The Journal of Business Strategy* 4(2): 3-15.
Mitra, M. (2006) *It's Only Business! India's Corporate Social Responsiveness in a Globalized World,* New Delhi, Oxford University Press.
Penrose, E.T. (1959) *The Theory of the Growth of the Firm*. New York: John Wiley.
Pfeffer, J. and Salancik, G. (1978) *The External Control of Organizations: A Resource Dependence Perspective*, New York, NY: Harper and Row.
Porter, M.E. (1980) *Competitive strategy : techniques for analyzing industries and competitors*, The Free Press, New York.
Porter, M.E. (1985) *Competitive Advantage*, The Free Press, New York.
Porter, M. and Kramer, M. (2002) The competitive advantage of corporate philanthropy. *Harvard Business Review* 80(12): 56-68.
Porter, M.E. and Kramer, Mark R. (2006) Strategy & Society: The Link Between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review* 84(12): 56-68.
Porter, M.E. (1996) What is strategy? *Harvard Business Review* 74(6): 61-78.
Reinhardt, F.L. (1998) Environmental product differentiation: implications for corporate strategy *Californian Management Review* 40(4): 43.
Ricks, (Jr.) Joe M. (2005) An assessment of strategic corporate philanthropy on perceptions of brand equity variables. *Journal of Consumer Marketing* 22(3): 121–134.
Russo, M. and Fouts, P. (1997) A Resource-Based Perspective on Corporate Environmental Performance and Profitability. *Academy of Management Journal* 40(3): 534–559.
Salancik, G.R. (1979) Inter-organizational Dependence and Responsiveness to Affirmative Action: The Case of Women and Defense Contractors. *Academy of Management Journal* 22(2): 375-394.
Salzmann, Ol., Ionescu-somers, A. and Steger, U. (2005) The Business Case for Corporate Sustainability:: Literature Review and Research Options. *European Management Journal* 23(1): 27-36.
Scott, W.R. (2003) *Organizations: Rational, Natural and Open Systems* (5th edition), Prentice Hall.
Smith, C.N. (1994) The new corporate philanthropy. *Harvard Business Review,* May/June, pp. 105-115.
Swanson, D.L. (1999) Towards an integrative theory of business and society: a research strategy for corporate social performance. *Academy of Management Review* 24(3): 506-521.
Teece D.J., Pisano, G. and Shuen, A. (1997) Dynamic capabilities and strategic management. *Strategic Management Journal* 18(7): 509-533.
Trainer, T. (2005) Social responsibility: The most important and neglected problem of all? *International Journal of Social Economics* 32(8): 682-703.
Valor, C. (2007) A global strategic plan for corporate philanthropy *Corporate Communications: An International Journal* 12(3).
Walley, N. and Whitehead, B. (1994) It's Not Easy Being Green *Harvard Business Review* 72(3): 46-51.
Walsh, J.P., Weber, K. and Margolis, J.D. (2003) Social issues and management: Our lost cause found. *Journal of Management* 29(6): 859-881.
Wernerfelt, B. (1984) The Resource-Based View of the Firm. *Strategic Management Journal* 5(2): 171-180.
Williamson, O.E. (1981) The economics of organization: The transaction cost approach *The American Journal of Sociology* 87(2): 233.
Williamson, O.E. (1985) *The economic institutions of capitalism: Firms, markets, relational contracting*, New York, NY: Free Press.
Windsor, Duane (2006) Corporate Social Responsibility: Three Key Approaches *Journal of Management Studies* 43(1): 93-114.

Contribution of Location Theories for Regional Development: Why some Technology-Based Firms Choose to be Rural?

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Abstract

This research aims to identify the factors which influence the location of technology-based firms. Accordingly, we propose a conceptual research model on the location of firms, based on the neoclassical, behavioural and institutional views. In order to reach the objectives of our research, an empirical study was developed based on a questionnaire filled by 203 technology-based firms located in the Beira Interior region (Portugal). The resulting data was subject to two types of statistical analyses: bivariate and multivariate. It was possible to identify crucial factors that mostly influence the location of these firms. These factors were: (i) founder's wish to live in a particular locality, (ii) employees' wish to live in that particular locality; (iii) proximity to the residence of the founder; (iv) birthplace of the founder and (v) the level of economic activity in the region.

Keywords: Location Issues, Regional Development, Technology-Based Firms

1. Introduction

Entrepreneurship, as well as the factors behind its existence and their influence on regional economic development, has been studied by several authors (Birley, 1985; Kirchoff and Phillips, 1988; Storey, 1994). The question of regional development has interested a range of both national and international researchers (Cooke, 2002; Lopes, 1998; Rego, 2003; Santos, 2002). On a national level, the importance of the topic lies mostly in the existence of national asymmetries, while, on an international perspective, interest is correlated to all events affecting Europe and, more precisely, the European Union. Entrepreneurship is thus presented as something that contributes to regional development (Raposo *et al.* 2004). Accordingly, the White Paper (2001) produced by the NCOE (National Commission on Entrepreneurship) stresses that its major contribution, on a local level, is innovation. Questions on location theories are inevitably linked to the question of entrepreneurship and its relevance to regional development. That is to say, what makes entrepreneurs, who are responsible for the entrepreneurial activity; choose a particular location to set up their business?

Regional development, particularly in (more) peripheral regions, is normally associated to major capital investment, to the application of technical and scientific resources in the productive systems and to profound economic change. Rural areas are still lagging behind their urban counterparts, particularly regarding technology-based firm formation (Roper and Love, 2006). Given the importance of regional development and location theories, we shall aim to identify, in the present research, the reasons which lead technology-based firms to set up in a particular region, with particular emphasis on the factors which influenced the decision to locate technology-based firms in the Beira Interior Region (Portugal).

2. Contributions for regional development

According to Alberto (2008), the concept of regional development is a result of the integration of the variable space in the topic of

development, which thus appears linked to a concrete spatial reference – the region. Territorial development achieved a level of importance in the 1990s that only finds parallel in the post-war issues around growth. The importance of this topic is clearly perceptible on two levels: international and national. In what concerns the international level, the development of Eastern Europe into new political and administrative models. The unification of Germany, the European monetary union and the multiplication of international organizations with a significant degree of economic and political integration are a good example of this. On a national level, the presence of profound local asymmetries, the economic protection of Portuguese borders, the concern with the efficacy of financial efforts to promote a balanced development, the need to clarify and evaluate the role of political and administrative decentralised structures in the promotion of development, make the issue of territorial development very much a current one, of unprecedented relevance (Lopes, 1998).

Rego (2003) proposed a new concept of regional development, that of 'learning region'. Qualifying a region as a 'learning region' means that the players in the system are involved in learning processes that allow the development of knowledge, know-how and other competencies, which are necessary for innovation and sustained competitiveness. In order to be efficient in a borderless world economy, regions must present the same characteristics as firms with a strong knowledge-based component: permanent improvement, new ideas, knowledge creation and ongoing learning. The key to the existence of 'learning region' lies in the presence of human infrastructures and institutional mechanisms that foster interactive learning. Thus, the capacity to encourage the return to universities throughout people's active lives is vital to ensuring knowledge update and maintenance of the capacity to innovate.

Intelligent regions are territories which are specially oriented and prepared to offer a series of conditions which favour the recreation of a relationship culture and collective learning dynamics, with the strategic purpose of producing knowledge and innovation. For this reason, and thanks to these specific factors, they are no different from the more developed concept of innovative environment. Amongst other characteristics, intelligent regions have a series of specific assets which distinguish them from the competition, and allow them to be better positioned, in terms of coherence and strength, to face multinational productive capital (Santos, 2002). This idea is associated to the concept of 'knowledge economies' (Cooke, 2002). According to this author, these 'knowledge economies' face three clear challenges: to fight regional imbalances; the fact that the activities of modern economies are increasingly knowledge-based; the concentration of knowledge-based economic activities in clusters. In this context, entrepreneurship, innovation, knowledge spillovers and KIBS (Knowledge Intensive Business Services) contribute to regional development and location theories.

3. Theoretical views on firms' location

According to Silva (2005), the spatial distribution of economic activities results from opportunities and location strategies devised in accordance with particular objectives. However, decision-making processes are complex and involve an important economic component, since a large part of human activities require the use and sharing of limited resources. In the opinion of Capello (2007) there are two groups of theories (which he refers to as "regional economics") that look into the issue of economic logic, which intends to explain the location of firms or, in other words, the existence of areas that are more developed than others: (i) Location theories: economic mechanisms that cause the distribution of activities in space; (ii) Growth and regional development theories: they focus on spatial aspects of economic growth and on territorial distribution of income. Location of economic activity can be analysed through three distinct views (Hayter, 1997): (i) the neoclassical, which focuses mostly on the location theory and centres its analysis on profit maximization strategies and minimization of costs (ex. transportation costs, human resources costs and external economies; (ii) institutional, which states that it is important to consider not just the firm's search for an appropriate location but also the institutional milieu it is part of (clients, suppliers, commercial associations, regional systems, the government and other

firms); and (iii) behavioural, which focuses on situations of uncertainty and lack of information.

Of all the literature on location factors of technology-based firms that was reviewed, we chose to follow the theoretical classification advanced by Hayter (1997). According to Hayter, these three views have the purpose of demonstrating how complex the reasons that motivate the location of a particular economic activity are, and they allow us to analyse factors of location at a more 'micro' level. Hayter (1997) defined the frontiers between these views in a more comprehensible manner. In his opinion, these are unclear in the literature that has been produced. Thus, we shall now provide a brief characterization of these views.

3.1. Neoclassical view

Several research studies, as will be shown, centre on the location factors of technology-based firms. However, few of these insights reflect on the motives which led firms to set up in rural areas. The reason behind this lack of information lies, probably, in the small number of firms located in rural areas. Nevertheless, and thanks to the development of information technologies, particularly the Internet, Grimes (2000) identified an increase in the number of firms which set up in those areas. According to Ouwersloot and Rietveld (2000), one of the key factors for economic development is technological innovation: the introduction of new production techniques, products or services. However, the emergence of these new factors is usually preceded by an intensive R&D process. Thus, and in the view of these researchers, the location of R&D activities is influenced by several factors. They have then identified four factors that are external to firms and which may influence location decisions: (i) labour offer; (ii) knowledge infrastructures; (iii) physical infrastructures; and (iv) agglomeration effects. These researchers concluded that the factors that make firms decide to set up in a particular region depend on the type of firm. In other words, for traditional transformation firms, the industrial composition of the place where they will be based is a key factor. If the firms are service-based, what influences them most in their choice of location is physical infrastructures and knowledge.

Holl (2004) focused his research on the impacts that the new transport infrastructures had on emergence of new manufacturing firms. Contrary to many previous studies, this work based its analysis at a micro level basis, in order to assess the variations on location at a detailed geographical scale. Through empirical results, the author concluded that in a country such as Spain, where the highway road system was developed recently (1980-1994) and where intra and inter-regional differences are clearly visible, access to road infrastructures makes all the difference when it comes to deciding where to set up a new firm. Costa *et al.* (2004) analysed the mechanisms behind the location of new technology based firms and proposed that it was linked to the type of industry and the product life-cycle on which the firm based its activity. Therefore, when the entrepreneur finds a place to set up his firm, he should evaluate if the environment is the most favourable to carry out his production process. This environment may be more or less populated and it may contain a greater or smaller variety of productive activities.

Nonetheless, through their empirical study, they came to the conclusion that the most populated and developed cities have lost their attractive edge, regarding the location of firms, to their smaller and more rural counterparts. Yet, when they looked at new science-based firms, they realised they prefer to locate and be part of the large cities. Thus, the location of firms is as near or remote from major urban centres depending on the type of firm and the activity it pursues. Focusing now on Hayter's perspective, it can be said that, according to the neoclassical view, the location of firms lies essentially on the power of economic forces. The truth is that, in practice, and depending on the profile of the entrepreneur, he may well ignore the power of these forces. According to Hayter, this situation often has a perverse influence in the location theories when researchers strictly defend the neoclassical view, given that, through common sense, as well as a result of economic advantages. When entrepreneur choosing the location for his firm, takes into account all types of costs, thus deciding where to set up where costs are lower. It is precisely because of these issues, and because, in Hayter's view, this factor does not explain, in itself, the location of firms.

He developed two theories that are henceforth presented: the institutional and the behavioural. In sum, in this type of view, the authors argue that the factors which enable the emergence of firms are road infrastructures, more or less populated places and the type of industry to be set up.

3.2. Behavioural view

Galbraith (1985) studied 98 entrepreneurs of high technology firms with an average of 670 employees each in Orange County, California (USA). He concluded that high-technology firms, in their location decision process, operate within a framework of factors that are different from those observed in traditional industries. The author identified three factors that determine the location of this type of firms: evaluation of individual and professional character; culture and way of living; and the wish of the founder of the firm to leave in that locality. These conclusions are equally shared by Arauzo and Viladecans (2006) in their study on the level of spatial concentration of new firms (in the period 1992-1996) in the municipalities of Spanish urban areas. Those authors believe that the process of sub-urbanism is particularly important to high-technology based firms. These firms move from big cities in large urban areas (their traditional location) to smaller cities. This, as a result, end up improving their accessibility, thanks to investments in road infrastructures. In fact, smaller cities appear to be preferred for the location of technology-based firms. Because they offer a quieter environment, better quality of life and become highly advantaged by the presence of qualified individuals working in these industries.

Felsenstein (1996) argues that urban areas enjoy a physical network of infrastructures that is better than in non-urban areas (ex. telecommunications), this being a sufficient condition for entrepreneurs to prefer them as locations for their firms. Nevertheless, and based on a study on a sample of 160 firms, both in urban and non-urban areas in Tel Aviv (Israel), he analyzed the trend of high–technology firms to choose urban areas as a location. The author concluded that the location of firms does not follow a strategy or a calculation. It appears to be particularly the case of small new firms which emerge within a locality, without a defined background strategy. Yet, he noted and concluded that one of the characteristics of the network of new firms lies precisely in the fact that they are not located in urban areas. According to Hayter (1997), the location of many firms is explained by this view, since many entrepreneurs, when deciding on where to set up their firms, end up choosing the places where they were born, pushing neoclassical factors aside. For him, this perspective goes against economic principles, since only behavioural factors are subject to assessment. Nevertheless, this view accounts for the appearance of the majority of small and medium-sized firms. In sum, the researchers argued that the location of firms lies mostly in the quality of life and personal characteristics of entrepreneurs.

3.3. Institutional view

A different perspective to the study on the location of technology-based firms, the institutional view, is the one offered by Elgen *et al.* (2004). Their research aims to analyse the role that public research institutes play in capturing/attracting new technology-based firms. For that purpose, they selected to 20,000 new German firms specifically on the basis of their deep knowledge of research institutions. The results demonstrated that these start-up high-technology firms tend to trust science with a high degree of intensity, which made them set up near research institutions. Nevertheless, new service-based firms tend to move away from the very same institutions. Thus, it can be said that, depending on the degree of technology that is necessary to the activity of a particular firm, it will be located nearer or further away from research institutions. Meyer (2003) further developed the research that was previously carried out by other authors, as, for him another key fact that influences the location of firms is the presence, at a given locality, of a business incubator, because this type of institution is of extreme importance when it comes to deciding where to locate a firm in a particular place. In a similar study, with technology-based firms as a basis for analysis, Audrestch *et al.* (2005) stressed the importance of access to knowledge spillovers when new technology-based firms decide on their location. In this model, the authors include: distance, in kilometres, from firms to the universities, the number of scientific

articles published by the universities, the number of students studying exact and social sciences, the number of inhabitants, the price of an overnight stay at the most expensive hotel in town and the firms' average age. Their results revealed that new high-technology firms are influenced by factors other than regional traditional characteristics, such as the opportunity to access knowledge generated by universities. Autant-Bernard *et al.* (2006) analyzed the determining factors in the creation of new biotechnology firms in France over the last decade (1993-1999), in order to understand the role of the environment in the commercialization of scientific results. They based their research on three key determining features: proximity to knowledge resources, surrounding milieu and industry's surrounding milieu. Their results demonstrated the need for the existence of a large and diversified scientific basis inside a region to enable these firms, after they were set up, to continue their activity for many years. Looking at the example provided by another country (Spain), Alonso (1999) and Trullén (2001) argued that the major technology-based firms tend to group together in the periphery of large urban areas; particularly when these newly set up firms have over 100 employees. Therefore that they can benefit from the technology created by other agents, at lower costs. According to Hayter (1997), there are also entrepreneurs who prefer to set up business near universities, research centres and governmental bodies, in order to provide more adequate support to the activities they intend to develop within their firms.

In sum, the authors we have referred to believe that the factors that decide the location of firms are determined by the presence of a business incubator, proximity or distance from public research institutes and from more or less populated cities. Given the systematization that has been presented, and considering the three views to the location of technology-based firms, we present, in Figure 1, our own research model. The model intends to highlight the main factors that influence location decisions by technology-based firms.

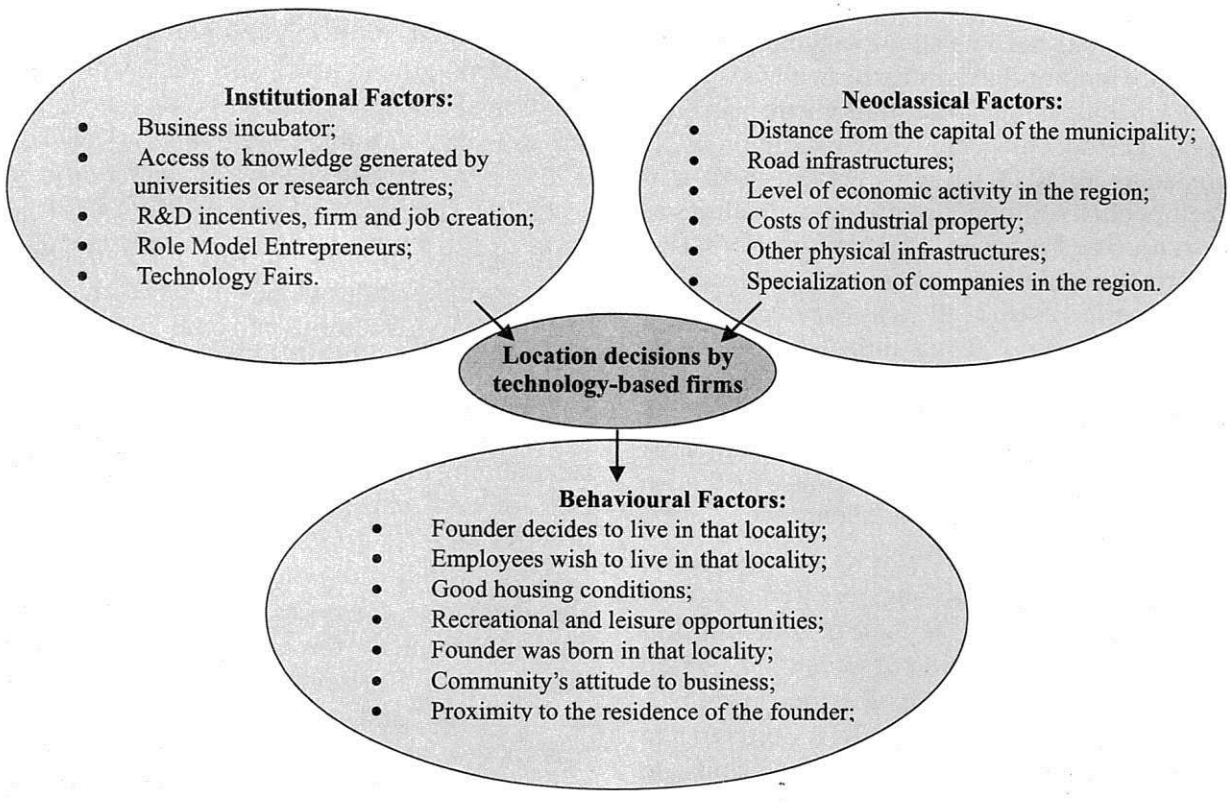

Figure 1: Proposed research model

Given the conceptual model, research hypotheses regarding each of the location factors shown in the model have been formulated (Table 1)

4. Methodological and statistical procedures

The classification of technology-based industries includes the OECD (2003) classification for R&D intensive manufacturing industries, given the major contribution that these firms may give to the country in terms of R&D production, wealth and added value. Four key categories have been identified: (i) high-technology industries; (ii) medium-technology industries; (iii) medium-low- technology industries; and (iv) low-technology industries. Our database was built from the database supplied by the support of regional centre (NERGA for the district of Guarda), and by using of the telephone directory (yellow pages for the district of Castelo Branco), since we were not able to obtain the necessary information from the institutions. Our database includes 550 firms, of which 60% are high-technology, 14% are medium-technology and 26% are low-technology firms. We obtained 203 answers, representing a response rate of 36.9%. The questionnaire is formed by closed questions, using a likert scale. The respondents were the entrepreneurs – firm's owners.

OECD has been using population density to measure rurality, that is, all areas with fewer than 150 inhabitants per square kilometre are rural areas (1996). In regional terms, the OECD considers all NUT III areas with over 50% of their population living in rural municipalities to be rural. The European Commission (1997) also resorts to population density to measure rurality, and classifies as rural all areas with a population density below 100 inhabitants per square kilometre. Based on these criteria, our unit of analysis (Beira Interior region) is rural in all the localities that it comprises, as we shall next demonstrate. We used the face-to-face method in our research, in order to obtain the highest possible number of responses.

The objectives of our research were to analyse and identify the factors which inform decisions on the location of technology-based firms in the Beira Interior Region (Portugal). We aim to: (i) empirically validate the proposed conceptual model on decisions on the location of technology-based firms in Beira Interior; (ii) identify which factors influence the location of technology-based firms in Beira Interior; and (iii) characterize firms according to distinct technology levels and detect eventual differences between levels. In order to identify the location factors of high, medium and low-technology firms in Beira Interior, we carried out a factor analysis on 19 items of the questionnaire, with the SPSS 15. The objective for using the factor analysis technique was to obtain a reduced number of factors which allowed us to identify the structural relations amongst the nineteen variables which measure the importance of factors in the location of firms.

The extraction method of the factors to be used was the main components method, using the varimax method, with the purpose of obtaining a factorial structure in which one, and only one of the original variables, is strongly associated to just one factor, and weakly associated to the other factors. The Bartlett method (minimum mean square method) was used to determine the factor scores. The factor analysis of the main components for the nineteen variables that we studied included 196 firms. All the variables that saturated more than one factor were discarded (the saturation criteria was coefficient 0.40). No item was eliminated, and the nineteen variables were kept (KMO = 0.759 and Bartlett's test of sphericity = 1347.702; significance level: 0.000).

In agreement with the rule for extracting factors with singular values higher than 1, we extracted five factors (personal motivation; innovation and incentives to firm formation; characteristics of the locality; economic expansion in the region; and conditions of the surrounding milieu) which account for around 62% of total variability. The factor analysis process was started by eliminating the variables with factor weights of less than 0.40, absolute value, from the components' matrix. Table 2 depicts the group of 19 items distributed by 5 factors, the singular values for each factor and the explained variance percentage, and the internal consistence of each factor, using Cronbach's alpha coefficient.

The analysis of the internal consistence of each factor yielded alpha acceptable values

Table 1: Research hypotheses

Size	Research hypotheses	Studies
Behavioural factors H1: Behavioural factors influence the location of high, medium and low- technology companies, in Beira Interior	H1a: The founder's wish to live in this locality influences the location of high, medium and low-technology companies	Elgen *et al* (2004); Mayer (2003); Audrestch *et al* (2005); Autant-Bernard *et al* (2006); Alonso and Trullén (2001); Hayter (1997)
	H1b: The employees' wish to live in this locality influences the location of high, medium and low-technology companies	
	H1c: Proximity to the founder's residence influences the location of high, medium and low-technology companies	
	H1d: Access to good housing conditions influences the location of high, medium and low-technology companies	
	H1e: The founder's birthplace influences the location of high, medium and low-technology companies	
	H1f: Recreational and leisure opportunities influence the location of high, medium and low-technology companies	
	H1g: The climate in the region influences the location of these companies	
	H1h: The community's attitude to business influences the location of high, medium and low-technology companies	
Neoclassical factors H2: Neoclassical factors determine the location of high, medium and low-technology companies, in Beira Interior	H2a: Distance from the capital of the municipality influences the location of high, medium and low-technology companies H2d: The cost of real estate influences the location of high, medium and low-technology companies	Grimes (2000); Ouwersloot and Rietveld (2000); Holl (2004); Costa *et al* (2004); Hayter (1997)
	H2b: Road infrastructures influence the location of high, medium and low-technology companies	
	H2c: Other physical infrastructures influence the location of high, medium and low-technology companies	
	H2e: The level of economic activity of the municipality/region influences the location of high, medium and low technology companies	
	H2f: The level of specialisation of companies in the region influences the location of high, medium and low technology companies	
Institutional factors H3: Institutional factors determine the location of high, medium and low-technology companies, in Beira Interior	H3a: The existence of a business incubator in the region influences the location of high, medium and low technology companies	Galbraith (1985); Arauzo and Viladecans (2006); Felsenstein (1996); Hayter (1997)
	H3b: Access to knowledge generated by universities, technology parks or research centres influences the location of high, medium and low-technology companies	
	H3c: R&D, company or job creation incentives in order to locate business in this region influence the location of high, medium and low-technology companies	
	H3d: Technology fairs organised regularly in the region influence the location of high, medium and low-technology companies	
	H3e: The "role models" in the region influence the location of high, medium and low-technology companies	

for all factors except factor 5, which presented an alpha value lower than 0.5. Accordingly, analysing the grouping of the variables in factors, the interpretation for the factors encountered is as follows: factor 1 is related to the firm founder's personal motivations (option of housing for employees and founders, residence near the location of the firm and birth place). Factor 2 is related to the level of innovation (business incubator, proximity to universities, technology fairs, the presence of role model entrepreneurs in the region and incentives to firm formation. The third factor refers to characteristics of the locality (attitude of the community to new entrepreneurs, and the level of infrastructures). The fourth factor refers to the possibility for economic expansion that the region can provide (road infrastructures, cost of land and level of economic activity). The fifth factor has to do with conditions of the surrounding milieu (good housing conditions, leisure opportunities, climate, and specialization of firms in the region).The factor analysis reveals that the proposed conceptual model has a slightly different application when applied to Beira Interior Region, in what concerns the aggregation of factors. Thus, our empirical model is as follows (Figure 2).

5. Location factors of technology-based firms

In order to extend our knowledge of the differences regarding the level of agreement regarding the location factors of our study, we used the Kruskal-Wallis test again. Which is not an alternative to the parametric test, but as a test that is appropriate to this measurement scale (1 - not important to 5 - very important), in other words, an ordinal scale. The test statistics allow us to conclude that factors Employees wish to live in the locality and Climate in the area led to a different level of agreement in the three types of technology, to significance level of 5%. In the 10% level, it was noted that factors Founder's wish to live in the locality, Proximity to founder's residence, Founder's birthplace in the locality, Recreational and leisure opportunities, Distance from the capital of the municipality, and Level of economic activity in the municipality/region present differences in the three technology types. Other factors did not reveal significant statistical differences.

In order to identify which were the decisive factors for the location of firms in the region of Beira Interior according to technological classification (low, medium and high), three variables designated by neo, inst and behv were created to quantify the importance given to location factors defined as neoclassical, institutional, and behavioural. In the research model the questions associated to each of these new variables can be seen. Given that the premises regarding the normality of the dependent variable and homogeneity of variances did not occur the Kruskal-Wallis test was used to test if there were differences regarding the importance of firm location factors, or, otherwise, if there are differences in the level of factor agreement regarding the type of technology. The hypotheses under study can be formally described as follows:

$$H_0 : \theta_1 = \theta_2 = \theta_3 \quad vs \quad H_1 : \exists i, j : \theta_i \neq \theta_j (i \neq j; i, j = 1,2,3).$$

On Table 4 of the test statistics, the significance probability calculated asymptotically can be seen (p=0.003) for which reason we reject hypothesis H_0. Regarding the variable which quantifies the importance of behavioural factors, we concluded that there is at least one type of technology with distinct agreement regarding location factors.

In what concerns the variables associated to Neoclassical and Institutional location factors, we do not reject the hypothesis of their influence being identical for the distinct types of technology, because p=0.450 and p=0.872 respectively. The analysis of Table 5 demonstrates that factors associated to the neoclassical and institutional views are correlated even if that correlation may be weak. Factors associated to the behavioural view are not correlated to the others.

6. Final considerations

In the present research we aimed to focus on two theoretical topics which, given their complex nature, have been playing an increasing important role. Initially we concentrated on regional development and on the various contributions to the topic. Then referred to the firm location theories, and here we focused

Table 2: Technology-based firms location decision factors: factor analysis of the main components, following varimax rotation

	Factor 1 Personal Motivation	Factor 2 Innovation and Incentives to firm formation	Factor 3 Characteristics of the locality	Factor 4 Economic expansion in the region	Factor 5 Conditions of the Milieu
Founder's wish to live in the locality	0.861				
Employees' wish to live in the locality	0.731				
Proximity to founder's residence	0.852				
Founder born in the locality	0.811				
Business incubator in the region		0.787			
Access to knowledge generated by universities, technology parks or research centres		0.732			
R&D incentives, creation of firms or of jobs to locate business in this area		0.774			
Regular technology fairs in the area		0.685			
'Role models' in the area		0.635			
Attitude of the community to business			0.523		
Distance from the capital of the municipality			0.784		
Other physical infrastructures			0.650		
Road infrastructures				0.722	
Cost of real estate				0.639	
Level of economic activity in the region				0.669	
Access to good housing conditions					0.568
Recreational and leisure opportunities					0.482
Climate in the area					0.648
Specialization of firms in the area					0.473
Explained Variance (%)	22.45	16.77	8.57	7.13	6.77
Consistency α Cronbach	0.859	0.768	0.575	0.582	0.386

KMO = 0.759 and Bartlett's sphericity test = 1347.702 (significance: 0.000)

particularly on three location theory perspectives: the neoclassical, the behavioural, and the institutional. It was precisely at this point that we formulated our research question, to which we now provide the answer: what are the reasons that make technology-based firms set up in a particular region? And particularly, which were the location factors in the case of technology-based firms in Beira Interior?

According to the results obtained it was possible to identify the following factors which influence the location of technology-based firms in the Region of Beira Interior:

(i) the founder's wish to live in the locality;

(ii) the employees' wish to live in the locality;

(iii) proximity to the founder's residence;

(iv) the founder's birthplace;

(v) the level of economic activity in the region (this factor only influences high and medium-technology firms).

We noted that the first four factors fell within the behavioural view, and only the fifth, and last, can be included in the neoclassical view. We can thus conclude that entrepreneurs with firms in Beira Interior were led by personal reasons when deciding on the location of their firms. In other words, they were primordially influenced by behavioural factors. This means that neoclassical factors had little weight in the decision on location, and institutional factors did not influence such decisions. Therefore, we are in a position to argue that besides personal reasons being pivotal to decisions on the location of firms in Beira Interior. The fact that the region is rural in all of its municipalities and not near to major urban centres probably is not, in itself, an obstacle to the creation of firms in the region.

As part of our research question, we stipulated three specific objectives: (i) to empirically validated the proposed research model on the decisions on location of technology-based firms in Beira Interior; (ii) to identify which factors influence the location of technology-based firms in Beira Interior; (iii) to characterize firms according to their distinct levels of technology and to detect eventual differences between levels. According to the findings, it has been possible to verify that high-technology firms are located in less rural areas than their medium and low-technology counterparts. Regarding the characterization of high, medium and low-technology firms, the fact that the factors are identical for the three types of technology must be stressed, because entrepreneurs, in what concerns their social and demographic characteristics, do not have a defined pattern for each type of firm, not in terms of age nor qualifications which explains why the importance attributed to factors is the same. It

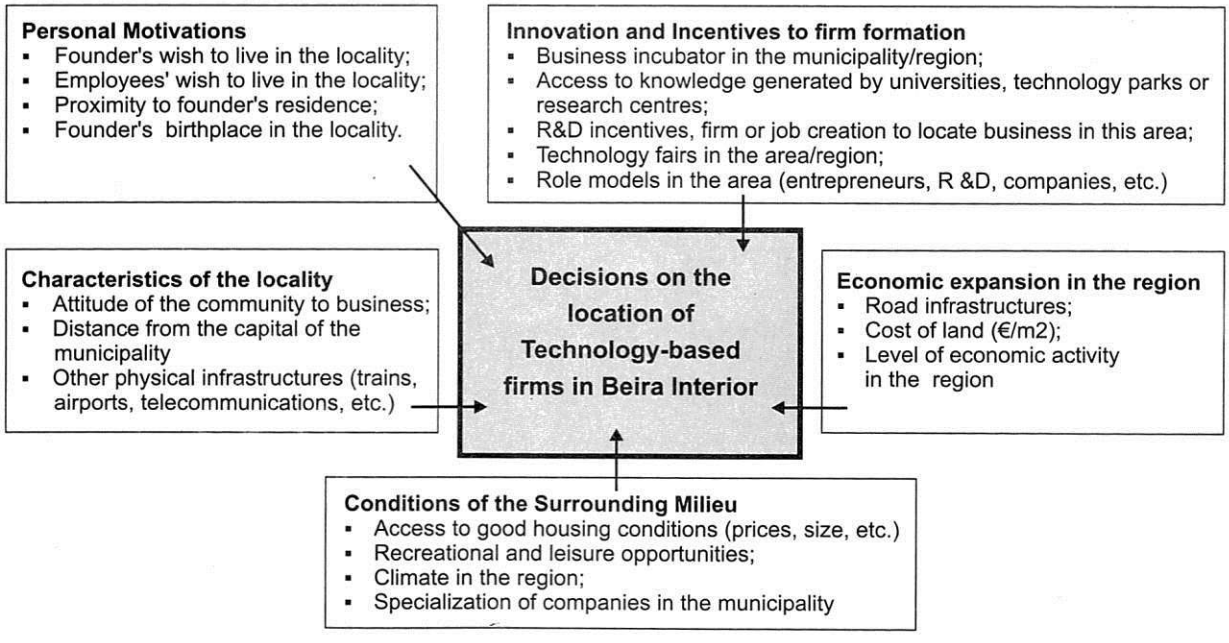

Figure 2: Empirical Model

Table 3: Kruskal-Wallis' Test applied to the nineteen Location Factors

Location Factors	Chi-square	d.f.	Asympt Sig.
Founder's wish to live in the locality	5.02	2	0.08**
Employees' wish to live in the locality	10.71	2	0.00*
Proximity to founder's residence	5.20	2	0.07**
Access to good housing conditions	0.26	2	0.88
Founder born in the locality	5.05	2	0.08**
Recreational and leisure opportunities	5.73	2	0.06**
Climate in the region	10.75	2	0.00*
Attitude of the community to business	1.56	2	0.46
Distance from the capital of the municipality	5.06	2	0.08**
Road infrastructures	0.80	2	0.67
Other physical infrastructures	1.85	2	0.40
Cost of land	3.27	2	0.20
Level of economic activity in the region	5.74	2	0.06**
Specialization of firms in the region	0.34	2	0.85
Business incubator in the region	0.14	2	0.93
Access to knowledge generated by universities. technology parks or research centres	0.87	2	0.65
R&D incentives. creation of firms or of jobs to set up business in this area	1.63	2	0.44
Regular technology fairs in the area	0.76	2	0.68
'Role models' in the area	1.67	2	0.43

* = $p < 0.05$; ** = $p < 0.10$.

has equally been possible to empirically validate the conceptual model presented despite the fact that it has undergone changes regarding the location factors of firms in the region of our study. This fact suggests that future research, applied to different regions, is required, so as to ascertain which factors carry more weight in the decision on location.

The findings of the study have important implications for both academics and policy-makers. Contrary to present literature, this study indicates that the location decision of technology-based firms in rural areas is not a fruit of calculative and rational economic thinking nor is it apparently swayed by the potential benefits that may come from institutional spillovers or from public incentives. Rather, the conclusions coming from the sampled entrepreneurs point towards a differential decision making process for rural technology-based firms that are more emotional revolving around the entrepreneurs' desire to establish residence or remain part of the rural community where they located their businesses. Some academics have tended to associate location decision of higher knowledge-based firms with greater economic rationality and strategic thinking. What this study has found is that in the case of the surveyed knowledge-based firms of Beira Interior, the search for a specific

Table 4: Kruskal-Wallis Test Statistics - Test Statistics (a.b)

Tests applied	Neo_Stand	Ins_Stand	Behv_Stand
Chi-square	1.598	0.275	12.578
Degrees of freedom	2	2	2
Asymptotic significance	0.450	0.872	0.002

a Kruskal Wallis Test; b Grouping Variable: Type of Technology

Table 5: Correlation of Factors by type of view

		Neo_Stand	Ins_Stand	Behv_Stand
Neo_Stand	Pearson Correlation	1	.334	.122
	Sig (2-tailed)		.000	.092
	N	195	195	.193
Ins_Stand	Pearson Correlation	.334	1	.001
	Sig (2-tailed)	.000		.991
	N	195	201	198
Behv_Stand	Pearson Correlation	.122	.001	1
	Sig (2-tailed)	.092	.991	
	N	193	198	198

life-style and quality of life dominated the business location decision making process. This means that policy makers could help sway a greater number of knowledge-based firms to locate in rural areas by making their localities more socially attractive and welcoming to technology entrepreneurs improve living conditions and quality of life.

References

Alberto, D. (2008) Modelos de Desenvolvimento Regional. In João Leitão, João Ferreira e Susana Azevedo (eds) Dimensões Competitivas de Portugal – Contributos dos Territórios, Sectores, Empresas e Logística, V. N. Famalicão: Centro Atlântico.

Alonso, L.F. (1999) Modelos de crecimiento y cambios espaciales recientes en las ciudades españolas: un programa desde el fin de siglo. *Papels de Economia Española*, 80: 231-247.

Arauzo J.M. and Viladecans, E. (2006) Industrial Location at the Intra-Metropolitan Level: A Negative Binomial Approach. Estudos de Economia Espanhola, 224, FEDEA.

Audretsch, D.B, Lehmann, E. and Warning, S. (2005) University spillovers and new firm location. *Research Policy* 34: 1113-1122.

Autant-Bernard, C., Mangematin, V. and Massard, N. (2006) Creation of Biotech SMEs in France. *Small Business Economics* 26: 173-187.

Birley, S. (1985) The role of networks of cities and growth in regional urban. *Journal of Business Venturing*, 1: 107-117.

Capello R. (2007) Regional Economics. Advantage texts in economics and finance, New York: Routledge.

Cooke, P. (2002) Knowledge Economies – Clusters, learning and cooperative advantage. Studies in International Business and the World Economy, London & New York: Routledge.

Costa, M.T., Segarra, A. and Marsal, E. (2004) The location of new firms and the life cycle of industries. Small Business Economics, 22: 265–281.

Elgen, J., Goottschalk, S. and Rammer, C. (2004) Location decisions of Spin-Offs from public research institutions. *Industry and Innovation* 11(3): 207-223.

European Commission (1997) Rural Developments. CAP 2000 Working Document, V/1117/97

Felsenstein, D. (1996) High – Technology firms and the metropolitan locational choice in Israel; A look at the determinants. Human Geography, 78 (1): 43-58

Galbraith, C.S. (1985) High–Technology location and development: the case of Orange Country. *California Management Review* 28(1): 98–109.

Grimes, S. (2000) Rural areas in the information society: diminishing distance or increasing learning capacity? *Journal of Rural Studies* 16(1): 13-21.

Hayter, R. (1997) The dynamics of industrial location: the factory, the firm and the production system. New York: Wiley.

Holl, A. (2004) Manufacturing location and impacts of road transport infrastructure: empirical evidence from Spain. *Regional Science and Urban Economics* 34: 341-363.

Kirchoff, B.A. and Phillips, B.D. (1988) The effect of firm formation and growth on job creation in the United States. *Journal of Business Venturing* 11: 133–149.

Lopes, R.G. (1998) Dinâmicas de Competitividade Territorial: Portugal por referência. Lisboa: ISCTE.

Meyer, M. (2003) Academic entrepreneurs or entrepreneurial academics? Research-Based ventures and public support mechanisms. *R&D Management* 33: 107-115.

NCOE. Embracing Innovation: entrepreneurship and American Economic Growth. National Commission on Entrepreneurship. White Paper, 2001; 1-11

OCDE (2003) Classification of manufacturing industries based on technology, Paris.

OECD (1996) Analytical Business Enterprise Research and Development Database, Paris.

Ouwersloot, H. and Rietveld, P. (2000) The geography of R&D: Tobit analysis and a Bayesian approach to mapping R&D activities in the Netherlands. *Environment and Planning* 32: 1673 – 1688.

Raposo, M., Serrasqueiro, Z., Silva, M. Ferreira, J., Leitão, J., Pereira, D. (2004) Cooperação Universidade Meio Envolvente. Comissão de Coordenação e Desenvolvimento Regional do Centro – CCDRC e Departamento de Gestão e Economia.

Rego, M.C. (2003) Análise de alguns impactos regionais da Universidade de Évora no meio envolvente. *Nova Economia e desenvolvimento regional* 2: 1019 – 1027.

Roper, S. and Love, J.H. (2006) Innovation and regional absorptive capacity: the labour market dimension. *Annals of Regional Science* 40(2): 437-447.

Santos, D. (2002) Teorias de Inovação de Base Territorial. Compendio de Economia Regional, APDR.

Silva, J. (2005) Acessibilidade, Competitividade e Desenvolvimento Económico e Social do Concelho da Covilhã. Série de Estudos Económicos, Universidade da Beira Interior.

Storey, D.J. (1994) Employment. Storey DJ (ed.) Understanding the Small Business Sector. London: Routledge, *Cap* 6: 160-203.

Trullén, J. (2001) Léconomia de Barcelona: cap a un nou model de desenvolupament. *Revista Situación Catalunya* 2: 26-38.

Rational Unified Process Methodology Frame Work - Tailoring Software in Software Development Process

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Abstract

Rational Unified Process (RUP) is a comprehensive software development process framework that has gained a lot of interest in industry. One major challenge in adopting RUP into use is to tailor it to specific needs. This study presents a review and a systematic assembly of existing studies. We have found that tailoring RUP is a considerable challenge by itself and that tendency is turning from large complete process frameworks towards smaller and more lightweight processes.

Keywords: Method Adoption; Method Tailoring; Rational Unified Process; Software Development Process

1. Introduction

As software development is a highly complex process; methodology support is a prerequisite for the completion of a successful software development project. There exist a wide variety of software development methodologies, spanning from heavy and bureaucratic processes to light-weight and dynamic processes. Lately agile processes have gained a lot of interest both in the industry and academia. A more mature direction within software development methodologies is the Unified Process (UP) (Jacobson, *et al.* 1999) and its commercial variant Rational Unified Process (RUP). There exist no exact figures on how many organizations have tried and used (R)UP – in any variant. However, an overview of experience reports from software engineering conferences, books and magazine publications indicate a considerable interest in UP and RUP. RUP is an extensive framework of collection of best practices described as a structured collection of process components; activities (what to do and how to do it), roles (by whom) and artifacts (what are the input and/or result of the activities). RUP contains detailed descriptions of these components and how they relate to each other. To establish structure, these components are organized in two dimensions; first by phases from inception to elaboration and then by a set of disciplines adhering to common SE activities. In addition, RUP is based on a few basic values; it is architecture centric, it is use-case driven and it is an iterative and incremental process. Having this completeness and complexity it is not intended to be a silver bullet process for all development project situations – RUP is a frameworks that must be tailored to the situation of use. It is an absolute necessity to do so to get the intentional value from using RUP.

Despite this indisputable interest, the total amount of empirical studies on the *adoption* and *introduction* of RUP is surprisingly low. A search for empirical studies identified only five studies that to some extent explain tailoring and introduction of RUP. We clearly delineate between simple lessons-learned reports that do not present information on context and study method and those that present these details as well as findings, analysis and conclusions. This leads to the aim of this paper: What do the software industry and the research community knows of the limitations, benefits, prerequisites and costs of tailoring and introducing Rational Unified Process? Thus, cost and benefit of RUP in *use* is outside the scope of this paper.

As RUP covers more or less all aspects of SE it may seem easy to take it into use. However there are many challenges in doing so successfully: how to know which parts to keep, exclude or alter, who should get involved in the process, how much time does it take, how is the result to be taken into use, how does one know that the result was good? To be able to answer

such questions and to pinpoint further research needs, at least in part, we have done a literature review of all existing relevant studies on tailoring and introducing RUP - holding a minimum of methodological quality. In addition, the compiled overview is extended with three case studies on the introduction and use of RUP that the we have done over the past few years (Hanssen *et al.* 2005a; Hanssen *et al.* 2005b; Westerheim and Hanssen, 2005; Westerheim and Hanssen, 2006) thus bringing together all available empirical experience on the topic.

This paper first describes the research method, both for the literature review and for the case studies. Results then are presented giving an overview of identified experience reports. A discussion summarizes findings from the literature review and our experiences giving a conclusion addressing the research aim of this paper.

2. Background: method tailoring

There exists a set of guidelines for tailoring and adoption of RUP; that specifically targets the issue (Bergström and Råberg, 2004) and covers the issue in some detail (Kroll and Kruchten, 2003). Additionally there exists a guideline documented through a website (Rational PEP. http://www1.ibm.com/support/docview.wss?uid = swg21158199). Further there is some guidance in the RUP documentation itself (Westerheim and Hanssen, 2005) or RUP-related books, (however these guidelines tends to be superficial). Despite the existence of these guidelines the authors have not been able to find any experience reports evaluating their outcome and suitability. On the other hand, there exist a set of experience reports addressing tailoring and adoption of RUP done in other ways. These experience reports are summarized and analyzed later in this paper.

The term methodology is defined as "A body of methods, rules, and postulates employed by a discipline: a particular procedure or set of procedures" by the Merriam- Webster dictionary. Basically, a methodology describes how someone, e.g. an organization, performs a task, e.g. software development. In our context we talk about methodologies for running projects with a given customer having more or less defined goals initially.

The process of adapting RUP can take many possible forms. IBM Rational, the provider of RUP has defined the Process Engineering Process(PEP)(http://www1.ibm.com/support/docview.wss?uid=swg21158199). This is a comprehensive adaptation process requiring a fairly large amount of resources (people and time). This may very well be appropriate for larger companies, but for the small ones this process may be too expensive. Adaptation of a framework, such as RUP, can take one of (at least) three approaches. The first is to do it in one step, for each project, thus representing a heavy job in each case. This can be justified for large projects. This approach may be called situational method engineering, as defined by ter Hoefstede and Verhoef (1997). The second approach is to do an up-front adaptation producing a subset of the framework, still being a framework, but now tuned to the organizations general characteristics (technology, customers, domain, traditions etc.). This is the intentional process of PEP and may be called method engineering, as defined by Brinkkemper (1996). The third approach is to first identify and describe a set of recurring project types. Having knowledge of characteristics and differences of these types, an adaptation is done for each type. No matter which approach is used; in the last step, a final adaptation is done in each case (project).

Adapting RUP in practice means to decide on which process elements to keep, remove, alter, add or merge. These decisions can be based on assumptions, experience, goals and visions. It is the quality of this underlying knowledge and experience that determines how good these decisions are. Having decided the content and principles of a process it must be made available to the users – the project team(s). Traditionally process descriptions have taken the form of voluminous printed descriptions. Today the most common form is through web-based process guides, RUP Online is such an example. In the case of RUP, IBM Rational provides a set of software tools to assist the reengineering of the process elements of RUP to build a coherent web based presentation of the result. Edwards *et al.* (1998) emphasized the importance of actively involving stakeholders in the process of tailoring situational specific methods. This will

both ensure that necessary detailed information becomes available and affects the tailoring process and that the resulting process actually is taken into use due to ownership and relevance. Various acceptance models such as TAM, TAM2, PCI and others (Riemenschneider *et al.* 2002) may help to explain and underline the importance of involving stakeholders that, after the tailoring, are going to use or be affected by the resulting process. For example, stakeholder participation may affect the *Usefulness*-construct (the extent to which the person thinks using the system will enhance his or her job performance) and the *Ease-of-use*-construct (the extent to which the person perceives that using the system will be free of effort).

3. Method

In this we first describe the study methods used in our three studies – each description is based on four parts: 1) a brief overview of the study context, 2) study aim, 3) data collection procedures and 4) method for data analysis and finally, in the last part of the chapter we present the method used to perform the literature review.

3.1. Case study A

3.1.1. Context

Company A is Deloite Software Consultancy Company with 50 employees mainly developing software systems with heavy back-end logic and often with a web front-end, typically portals. However, they also develop lighter solutions with most emphasis on the front-end. All development is done in the form of projects. The authors have followed A for a period of five years - having a varying focus over these years; First we studied how A initially used RUP, out-of-the-box, with no restrictions or guidelines. The study is reported in (Hanssen *et al.* 2005b). Secondly, we carried out an action research project to follow A in an attempt to tailor RUP to a predefined project type. The study is reported in (Hanssen *et al.* 2005a). Thirdly, and finally, we have carried out a case study of a pilot project at A using a heavily downscaled variant of RUP documented in the form of an internal Wiki-web. The results from this study are still not published, but are reported in this article.

3.1.2. Study aim

For the three studies, the study aims were respectively; to present an industry case to provide lessons learned and answers with respect to process uptake and effect. The second study aimed to provide others considering remodeling and adapting a process framework in general, and RUP in particular, an insight in how this has been done in a small software company. The third study aimed to study the use and effects of an extensively downscaled variant of RUP documented in the form of a Wiki- web.

3.1.3. Data collection

For the first study we first interviewed four project managers (claiming to be using RUP in four projects) to make a usage map per project to see what parts of RUP actually was being used. Then, we arranged semi structured interviews with five employees with varying roles to document main experiences and find potential explanations for use/no-use of RUP. For the second study we took an action research approach (Avison *et al.* 1999) following A in the whole process of tailoring RUP, as a group-process, to a defined project-type. In the third study we have interviewed the project manager and analyzed internal mid term- and end- PMA-evaluations (Birk *et al.* 2002) of the pilot project being studied.

3.1.4. Analysis

As all three studies have been descriptive with no hypothesis to validate we have done a qualitative analysis. For the first study, interviews were documented on- the-fly in a usage-map (excel spreadsheet) showing which RUP process components had been used or not with potential explanations from the interviewees. Further on, the interviews were transcribed and analyzed using the constant comparison technique (Seaman, 1999). In the second study which was organized according to the principles of action research our report (Hanssen *et al.* 2005a) contains a discussion that extracts and summarizes key learning's. In the third study we also used the constant comparison technique to extract key learning's from the transcribed interview and the internal project evaluations.

3.2. Case study B

3.2.1. Context

Company B Infotech Company is the software development department (300 persons) within a company with a total of 2000 employees. B is focused at both software development and consulting services within the domain of banking and transportation services. The authors have followed B over a period of two years, entering the scene about a year after the company's RUP specialization had been taken into use by projects. This study is reported in Westerheim and Hanssen (2005).

3.2.2. Study aim

The aim of the study was to investigate the level of use of a large-scale RUP specialization, explaining positive and negative experiences using the tailored process and reasons for use/no-use.

3.2.3. Data collection

In this case study we used three main sources of information; 1) a main contact person which was the leader of the tailoring of RUP prior to our study, 2) the process advisory board responsible of the tailoring and the introduction for the new process in the organization and 3) project managers and software developers. Our main method of data collection was workshops and semi structured interviews with these roles. We had three workshops with the project advisory board; information was recorded on-the-fly using mind-maps. We did two rounds of interviews, the first – interviewing representatives from eight projects face-to-face, mainly project managers. The second round of interviews was carried out one year later with the same eight interviewees, this time over telephone. All 16 interviews were recorded and transcribed for later analysis. The aim of the interviews was to document experiences from the introduction of the tailored RUP, find effects – both positive and negative, and to investigate the level of use and corresponding explanations.

3.2.4. Analysis

All transcribed interviews were analyzed using the constant comparison technique, the first eight interviews were coded and analyzed using the NVivo™-tool, the last eight were coded manually by two researchers in pair using a whiteboard. Lessons learned and experiences were counted across the interviews to find key learning of most significance.

3.3. Case study C

3.3.1. Context

Company C was a company specializing in the development of web applications with a high emphasis on the user experience of the web sites. The company had employed software developers and psychologists. The latter ones worked as producers, specifying the look and feel of the web sites, as well as the logical aspects of the use of the web pages. The company did develop both ecommerce applications and more entertainment types of sites. This study is reported by Westerheim and Hanssen (2006) and Westerheim *et al.* (2002).

3.3.2. Study aim

The aim of the study was to investigate how RUP could support the specifications and development of non-functional parts of a web site. The company had its own tailored RUP, where the original disciplines and the structure of RUP were not changed. The tailoring was a new user experience discipline, with dedicated activities to be performed by new roles.

3.3.3. Data collection

In this case study the main data source was the conducted Postmortem (Birk *et al.* 2002) analyses. Data from six different projects is included in the case study. The tailoring of RUP was already in place when the researchers started to cooperate with the company.

3.3.4. Analysis

The data in the PMA reports was analyzed using constant comparison.

3.4. Literature review method

A systematic review is a strategy for gathering and systematizing results from several independent studies sharing more or less the same thematic focus. The intention is to establish a compiled overview of all relevant experiences

and to identify gaps in existing knowledge, thus indicating the directions for further research. In this case we did a simplified review inspired by the guidelines described by Kitchenham (2004), hence we call it a literature review.

Systematic reviews have traditionally been used to systematize quantitative research, typically statistical meta-analysis. However, most software engineering method-focused experience reports so far are qualitative single-case studies. We therefore needed to adapt practices to be able to systematize qualitative data. This resulted in a review- protocol that we used to 1) define a common research question, 2) search for relevant literature, 3) select studies to include in an analysis and 4) systematize findings and lessons learned.

Step 1: A common research question

We defined the following question for the review: *What are the challenges, prerequisites and success criteria's for tailoring, introducing and using a software development method, e.g. RUP?*

Step 2: Finding relevant literature

The following SE index databases; ISI Web of science, Compendex and ACM Digital Library were searched using the phrase *unified process AND software.*

Step 3: Select studies to keep

All three authors participated in the evaluation of the search results using the following routine:

- **Deselect on title:** a coarse deselection of studies was done based on title, removing studies with an obvious wrong focus. The exclusions and inclusions were based on a few simple selection criteria: The study aim or topic had to be within the frames of *tailoring / adopting/ specializing / introducing the Unified Process or Rational Unified Process.* This is resulted in 100 unique studies.
- **Deselect on title and abstract**: The second selection criterion was: the study must present empirical data. This left 36 studies.
- **Deselect on full text**: Studies were excluded if they had insufficient quality with respect to 1) a well defined and limited study aim, 2) an adequate description of the study method, 3) a sufficient description of the study context, 4) a presentation of the study results, 5) a thorough analysis of the results and 6) giving conclusions or answers with respect to the defined study aim. This left 5 studies.
- **Final, group based selection**: Each resulting study was reviewed by each of the three authors discussing the six quality criterions defined above. This final step left 2 studies.

Step 4: Systematize findings and lessons learned

The main learning's or conclusions from the resulting studies were identified and expressed as claims. A claim can be seen as a hypothesis supported by at least one study.

4. Results

4.1. Case study A

The first part of the study, addressing RUP-use out-of-the-box concludes that a direct use of a framework, such as RUP, with no assistance, tailoring or guidelines results in low use. Introducing a methodology such as RUP is an investment beyond the license fee. In this case the outcome could have been better if the introduction of RUP was carefully managed and not left as an autonomous effort in each project. The second part of the study concludes that a success factor in tailoring RUP to a defined project type is to have focus on the features of the defined process and that a tailoring workshop should consist of persons with proper experience from case projects of the defined type. In the third study we saw that the main objection with the use of the small footprint process guide was lack of content, the project manager typically had a demand for more and better check lists. However, the content was still under development. The project manager commented that it has to be a balance between content size and the lightness as one of the main positive experiences was the simplicity of the guide – it was easy to find relevant guidance. As the process guide is a Wiki-web the project manager clearly saw a need of defining an editor role as editing is free to all and may compromise the content. The content which basically is a collection of activity descriptions organized

over the four RUP phases seemed appropriate for the case project; only four new activity descriptions were suggested. Beyond task guidance the project manager strongly demanded practical process support tools such as estimation models, project follow-up support, a testing framework etc. When asked to comment the difference between this light process guide and the complete RUP, the project manager emphasized the ease of use and clear relevance of the new guide as opposed to RUP's well of information that may be hard to find one's way through. However, interestingly, a definite premise of using such a minimum version of RUP is that the user must have a good understanding of the principles of RUP.

Claim A.1: RUP, out-of-the-box is over-comprehensive and will provide more confusion than guidance and consequently low uptake and use.

Claim A.2: Tailoring RUP efficiently must be based on best practice from the native organization and relevant project cases.

Claim A.3: RUP may be downscaled extensively to increase relevance and ease of use, however, a successful use requires a good knowledge of RUP principles.

4.2. Case study B

The findings resemble known models of technology acceptance (Riemenschneider *et al.* 2002); little knowledge of RUP and thereby low motivation results in low or no use. On the other hand, knowledge and motivation for RUP results in medium/extensive use. In relation, education seems to be an important factor, not only prior to the process but also continuously trough the use. Further, we found that management support seemed to be an important factor with respect to uptake and to continuously improve the process during use; this also resembles other similar studies (Dybå *et al.* 2004).

Claim B.1: Low knowledge of RUP creates low motivation and further low uptake and use.

Claim B.2: Management support is a success factor in tailoring and using RUP efficiently.

4.3. Case study C

The main result, when it comes to introduction of RUP, is that formalization of roles makes them more visible and understandable to others in a project. In this case, new roles related to graphical design were added to the RUP process resulting in a higher acceptance from more technical roles which consequently increased the uptake and use of RUP in the project.

Claim C.1: Explicit definition of roles makes them visible to other project members and thus positively affects the use of the process. Our search for empirically justified claims on RUP tailoring and adaptation resulted in only two study reports; a clear signal that more research is needed in this area. Here we summarize the claims these papers add to the research community. To assess the validity of these claims, we also include a short summary of the setting and research method described in each of the papers. The papers we identified were by Folkestad *et.al.* (2004) and Bygstad (2004).

Folkestad *et. al.* (2004):

Context: The specific case being studied was a project to transfer an existing system from mainframe architecture to a client-server based architecture. The company saw the project as an opportunity to rebuild and enhance the competence of their staff and was willing to spend resources on this. They chose to use a version of Unified Process as their software development approach. The size of the project was about 30 man-years and lasted three years.

Study aim: The study aims are clearly stated as 1) Identify the effects of changing to a new process. 2) Identify the causes for these changes. 3) Identify properties of the new work process that were instrumental in the change.

Data collection: The data was gathered after the project had been running for one year. The main sources were seven semi-structured depth interviews with members of the software developer group. In addition some data was gathered through informal discussions and from the business documents regarding the development process and the project.

Analysis: The data was analyzed qualitatively using a method called Activity Theory, which can be considered "a framework for the understanding of human activity".

Limitations: Openly discussed in the paper.

Since it is a single case study, it is not easy to generalize the results. Factors like openness, flat hierarchy, and confident staff may be the cause behind the results, just as much as UP itself.

Findings: We have extracted the following findings based on this paper:

Claim R.1: The iterative approach of Unified Process will ensure large effects in terms of learning.

Claim R.2: Unified Process will improve on communication and work distribution in a company.

Claim R.3: Unified Process helps constrain activities and leads to developers being more focused on their tasks, and hence it has a positive influence on productivity and quality.

Claim R.4: As a project develops, elements of Unified Process will become internalized and become tools for the developers. Or in other words, the developers will focus less and less on UP in itself, but focus more on following the practices that they decide to adopt.

Bygstad (2004):

Context: A RUP development project at Scandinavian Airline System (SAS), carried out by the Wipro IT Group (SIG) (owned by SAS). The goal of the project was to establish a web based marketing channel, enable easy publishing and integrating it with the existing booking systems. SAS had chosen RUP as their standard software methodology two years prior to this project. RUP was tailored to the project, and was linked to established practices in SIG.

Study aim: The research questions are 1) how can the project manager control the integration challenge? And 2) what support is there in the software engineering frameworks like RUP?

Data collection: The case was followed for 18 months. Interviews were conducted over three intervals, project meetings were observed and project documentation analyzed.

Analysis: All data was coded with in-vivo codes, using only domain (project) terms. Then each iteration of the project was analyzed qualitatively using constant comparison methods.

Limitations: There is no discussion concerning external validity, but since it is a single case study, the results may not be easy to generalize. The internal validity is discussed in the paper with emphasis on how they addressed the principles of dialogical reasoning, multiple interpretations and member verification in their analysis.

Findings:

Claim R.5: RUP provides good support for internal technical integration and poor support for external technical integration.

Claim R.6: RUP provides weak support for internal stakeholder integration throughout a project.

Claim R.7: RUP provides strong support for external stakeholder integration in the early phases, but weak support in the later phases.

Claim R.8: RUP gives strong declinational support to step-wise external integration, but too little practical support.

Claim R.11: Using RUP as a basis, linking it to existing best practices results in a process that is actually used.

5. Discussion

The search for relevant empirical studies, with sufficient quality, on tailoring and introduction of RUP resulted in only two study reports. In addition to our three own studies this forms a very small experience base and it has shown to be hard to see any trends across these studies.

From the studies we see that RUP initially is too complex to be used without any tailoring which in practice means that the project manager must make more or less ad- hoc decisions. This becomes an error prone process if the knowledge of the content of RUP is low and thus makes it hard to decide upon which elements to keep, alter or avoid (Hanssen *et al.* 2005b). The RUP-online documentation is a comprehensive collection of process elements and their relations containing about 3700 web pages – which makes it necessary to have a detailed knowledge about the content to be able to select a consistent subset suitable for a given context of use. In the first attempt to deselect RUP elements in case study A we saw that insufficient knowledge of such details quickly became a problem. In case study B a dedicated team needed to get assistance from a trained RUP mentor to be able to accomplish a

successful tailoring. In the second attempt in case study A, a bottom-up approach was used – building a small process guide based on existing best practices using RUP merely as inspiration rather than a commodity. This approach made it at least possible to accomplish the task and resulted in a complete process guide that was taken into use by project teams. In this case, almost all users of this heavily downscaled RUP-process had very high knowledge of RUP through training. This made it possible to use simplistic guidelines as the users knew the details or at least where to find them when needed. The resulting process guide itself in case A was a simple overview of the most important high-level tasks to perform in a development project – no templates or process maps were included. So, the resulting process and its web-based representation can be characterized as minimalist, thus raising the question to what RUP was; how much do you have to keep unaltered to still call it RUP and when is it merely inspired by RUP that by it self is a collection of already existing best practices and guidelines? As a contrast to case A where the basic knowledge of RUP was high we saw in case B that the intended users had little knowledge which clearly affected their motivation for use which consequently also resulted in low uptake of the new process - even though it in this case was tailored to their project characteristics by a dedicated tailoring team. Other studies also support this in the case of acceptance and uptake of electronic process guides (Dybå *et al.* 2004). It is reasonable to believe that low knowledge negatively affects these motivational factors. Further on, in case B, we found that management support was a success factor – one project in this case study was found to actually use RUP and report a certain level of success of doing so. In this case the management had been clear in their expectations that the project should use RUP and supported this. In other projects in the same case study, management was more absent which made the project members use their own varying best practices, thus hampering the goal of establishing a corporate unified development process. Another potential success factor for uptake was found in case study C. As RUP clearly defines roles it became evident how each role was needed and how they related to each other through joint activities and shared facts. This increased the acceptance of existing roles that was not documented to be a part of the total development process. We have not followed our own cases to assess the use of RUP over time, however Folkestad *et al.* (2004) found that developers, over time, will focus less and less on the process in itself, but focus more on following the practices that they decide to adopt. Thus, the value of introducing RUP may have important effects when it comes to learning a new shared process.

An interesting note in the context of RUP and the challenge of making it fit to local needs and context is the recent spirited development of agile processes (Cockburn, 2002). Ivar Jacobson, one of the contributors to RUP has recently initiated a total remake of RUP, resulting in something called the Essential Unified Process (EssUP). This is intended to be a great improvement of RUP and Jacobson says in a whitepaper (Jacobson *et al.* 2006): "The *Unified Process became too heavy, the process improvement programs required too much boring work...* ". This is interesting since RUP for years has been marketed as a framework that could help most software organizations in professionalizing software development effectively. EssUP can simply be described as a combination of RUP – which may be seen as a heavy type of process – and agile software development principles (Agile Manifesto: http://www.agilemanifesto.org). Our findings, both from our own studies and others support the view that RUP is too heavy and that it may require too much tedious and difficult work. The question is; will a combination of RUP and agile be a better approach? Others as well has addressed the challenge of making RUP simpler and agile which, in sum, can be seen as a shared opinion that RUP have its limitations despite its comprehensiveness. This adds to our findings summarized in this paper.

RUP has, since its creation, gone through several transformations, all leading towards a more agile approach of designing and developing software. This has resulted in various variants and spin-offs of the process, followed by numerous books and even more presentations, speeches, courses and consultant services. It is hard to predict where this will end; however, based on our findings we see a clear need of simplifying RUP (and other processes) to ensure uptake and efficient use. The

development turns clearly towards the agile side of the spectrum – perhaps in search for a balance between discipline and agility (Boehm and Turner, 2004).

6. Conclusion

Based on our, and a few other empirical studies on tailoring and introduction of RUP into development organizations we found that there exist few or none (reported) direct success stories. All experiences pull in the same direction; RUP is, out of the box, too complex, however, tailoring it to specific needs is also too complex. Looking at the evolution of RUP itself over the past years and the cases we summarize here we see a clear need for, and movement towards, a more agile process that can bee tailored with less effort.

References

Avison, D. *et al.* (1999) Action Research. Communications of the ACM, 42(1): 94 (4).

Bergström, S. and Råberg, L. (2004) Adopting the Rational Unified Process, Addison-Wesley, pp. 165-182.

Birk, A., Dingsøyr, T and Stålhane, T. (2002) Postmortem: Never Leave a Project without It. *IEEE Software* 19(3): 43-45.

Boehm, B. and Turner, R. (2004) Balancing Agility and Discipline - A Guide for the Perplexed: Addison-Wesley.

Brinkkemper, S. (1996) Method engineering: Engineering of information systems development methods and tools. *Information and Software Technology* 38(4): 275-280.

Bygstad, B. (2004) Controlling Iterative Software Development Projects: The Challenge of Stakeholder and Technical Integration, In: Hawaii International Conference on System Sciences, Hawaii, USA.

Cockburn, A. (2002) Agile Software Development. The Agile Software Development Series, Ed. H.J. Cockburn A.: Addison-Wesley.

Dybå, T., Moe, N.B. and Mikkelsen, E.M. (2004) An Empirical Investigation on Factors Affecting Software Developer Acceptance and Utilization of Electronic Process Guides. In: METRICS, Chicago, USA.

Edwards, H.M., Barrie Thompson, J. and Hardy, C.J. (1998) Developing situationally specific methods through stakeholder collaboration. In: Computer Software and Applications Conference (COMPSAC).

Folkestad, H., Pilskog, E. and B. Tessem (2004) Effects of Software Process in Organization Development – A Case Study. In: Learning Software Organizations (LSO).

Hanssen, G.K., Westerheim, H., Bjørnson, F.O. (2005a) Tailoring RUP to a defined project type: A case study. In: Profes, Oulo.

Hanssen, G.K., Westerheim, H., Bjørnson, F.O. (2005b) Using Rational Unified Process in an SME - A Case Study. In: EuroSPI, Budapest.

Jacobson, I., Booch, G. and Rumbaugh, J. (1999) The Unified Software Development Process. Object Technology Series, Ed. G. Booch, I. Jacobson, and J. Rumbaugh., Reading, Massachusetts: Addison Wesley Longman Inc. p. 463.

Jacobson, I., Ng, P.W. and Spence, I. (2006) The Essential Unified Process – A Fresh New Start.

Kitchenham, B. (2004) Procedures for Performing Systematic Reviews, Keele University and Empirical Software Engineering National ICT Australia Ltd. p. 33.

Kroll, P. and Kruchten, P. (2003) The Rational Unified Process Made Easy - A Practitioner's Guide to the RUP, Ed. O.T. Series: Addison Wesley.

Riemenschneider, C.K., Hardgrave, B.C. and Davis, F.D. (2002) Explaining software developer acceptance of methodologies: A comparison of five theoretical models. *IEEE Transactions on Software Engineering* 28(12): 1110-1135.

Seaman, C.B. (1999) Qualitative methods in empirical studies in software engineering. *IEEE Transactions on Software Engineering* 25(4): 557-572.

ter Hofstede, A.H.M. and Verhoef, T.F. (1997) On the feasibility of situational method engineering. *Information Systems Journal* 22(6): 401-422.

Westerheim, H. and Hanssen, G.K. (2006) Extending the Rational Unified Process with a User Experience Discipline: A Case Study. In: EuroSPI, Joensuu, Finland.

Westerheim, H., Hanssen, G.K. (2005) The Introduction and Use of a Tailored Unified Process - A Case Study. In: Euromicro Porto, Portugal.

Westerheim, H., T. Dingsøyr, and G.K. Hanssen, (2002) Studying the User Experience Discipline extension of the Rational Unified Process and its effects on Usability - The design of a case study. In: Empirical Studies in Software Engineering: Proceedings of the First International Workshop, December 2002, C. Bunse and A. Jedlitschka, Editors, Fraunhofer IRB Verlag: Rovaniemi, Finland pp. 69-74.

Management of thiocyanate pollution using a novel low cost natural waste biomass

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Abstract

Environmental pollution caused due to the release of toxic and hazardous (T&H) chemical wastes from industrial processes is an issue of major environmental concern. 'Thiocyanate', one such T&H chemical, is encountered in several industrial effluents. Owing to its toxicity, its proper management by removal from liquid wastes using suitable cost-effective and efficient technology is the key. Management/removal by sorption using biomass is one such technology. Waste biomass (powdered dried leaves) of various photosynthetic plants (consisting of big trees and weeds) were screened for the removal of thiocyanate from the aqueous solutions. Among the tested biomaterials, *Mangifera indica* (Mango) biomass was found to be highly efficient biosorbent of thiocyanate. Biosorption of thiocyanate from solutions took place optimally in the pH range of 4 to 6 and biosorbent quantity of 3% (w/v). Loading capacity of *Mangifera indica* biomass (10.5 mg/g) was comparable with that of activated charcoal (11 mg/g), which was used as a reference material. Kinetic study showed that the process of biosorption was rapid and for maximum thiocyanate sorption the contact time required was 60 minutes. The experimental data showed that thiocyanate uptake values could well be fitted to the Langmuir and Freundlich adsorption isotherms models. When the process of biosorption was carried out under standardised conditions, a 10-17 fold concentration of thiocyanate could be achieved using sodium hydroxide as an eluting agent. Laboratory experiments thus, clearly indicate that thiocyanate could effectively be managed by its removal from aqueous solutions using low-cost natural waste biomass.

Keywords: Biosorption, Low-Cost, *Mangifera indica*, Pollution Management, Thiocyanate, Waste Biomass

1. Introduction

A surge in science and technology in the eighteenth century resulted in the industrial revolution beginning in England and France, which spread elsewhere from the mid nineteenth century worldwide during 1850. In the latter half of the twentieth century, the industrial sector expanded substantially thereby positively impacting economic growth in almost every nation. However, it also resulted in a significant depletion of natural resources with simultaneous deterioration of the quality of environment. In the past few decades, rapid industrial development and growth have taken theirs toll by increasing environmental pollution. The contamination of various environmental segments owing to the release of hazardous and toxic chemical wastes is one of the major problems faced by mankind. Often these chemicals prove to be highly toxic to plants, animals and humans, if improperly managed.

Industrial effluents can broadly be classified as wastes rich in organic matter on the one hand; and wastes rich in inorganic matter on the other. Cyano-group of chemicals and heavy metals (viz. copper, cadmium, chromium, iron, nickel, etc.) form a significant part of the latter type of wastes. One of the important family members of cyano-group of chemicals known is 'Thiocyanate'. Chemically, it is toxic in nature, negatively charged species (SCN^-) and contains one-carbon along with sulphur and nitrogen. Moreover, thiocyanate is linear, polyatomic ion and a good example of pseudohalides because of the similarity of its reactions to that of halide ions (Hughes, 1975).

Sources of thiocyanate include plants, biotic and abiotic decomposition and *in vivo* detoxification. Thiocyanate occurs naturally in plants like cauliflower, turnips and cabbage

present in the wastes. Therefore, removal of precious/important anionic species like thiocyanate and their metal-complexes from wastes requires immediate attention of scientists and technologists. The challenge is not limited only to their removal, but also extends to finding efficient and economical ways of possible recovery and recycling. It was thought by us that if an efficient process for removal/recovery could be developed, thiocyanate could be conserved, which in our opinion would be a novel approach of resource recovery. Since thiocyanate is an anionic species, in principle, well established physico-chemical methods can be used for removal/recovery of thiocyanate.

Overview on thiocyanate removal mainly focuses on (bio)degradation of thiocyanate and (bio)adsorption of metal "cations". Far less attention has been paid on biosorption of "anions" like thiocyanate, cyanide and their metal complexes using low-cost natural waste biomaterials. Microorganisms capable of metabolising/degrading cyano-compounds like cyanide and metal-cyanides are well documented and have been studied for a long time (Karavaiko *et al.*, 2000; Patil and Paknikar, 2000). Use of metabolically inactive (dead) microorganisms for the removal and recovery of metal-cyanides have also been reported (Patil and Paknikar, 1999). Successful attempts to set-up large scale biological treatment plant for the removal of cyanide, metal-cyanides and thiocyanates from mining effluents have been made on commercial scale (Whitlock, 1990).

In the light of the above background, the researchers in the present paper focussed on the use of a novel low-cost natural waste material (viz. powedered biomass of mango leaves) for the management (i.e. removal) of thiocyanate from aqueous solutions.

2. Experimental

2.1. Collection and processing of waste biomass

The biomass used in the present study comprised mainly of natural waste, dried leaves of various tree species viz. *Eucalyptus* sp. (Nilgiri), *Tectona grandis* (Sag), *Mangifera indica* (Mango), *Azadirecta indica* (Neem), *Casurina* sp. (Suru); *Jambulana* sp. (Jamun), *Delonix regia* (Gold Mohar) and *Artocarpus heterophyllus* (Jackfruit). Biomass of some commonly occuring weeds (i.e. unwanted plants) like *Parthenium* sp. (Congress grass), *Lantana camera* (Ghaneri), *Calycopteris floribunda* (Ukshi) and *Eicchornia* sp. (Jalparni) were also used for the study. All the biomass samples were collected from various locations in and around Kudal city of Sindhudurg District, located in the Southern parts of Maharashtra, India. Conventional sorbents like activated charcoal, saw dust and fly ash were used as reference materials. All the waste biomass samples were collected in polythene bags and transported to the laboratory. The biomass samples were then washed several times with distilled water (DW) to remove the dirt and other contaminants, if any, present on the sample. After washing, the samples were subjected to drying in oven at 50-60°C for 2-3 days till the constant weight was obtained. Later, the dried biomass was ground using mortar and pestle and was sieved so as to get uniform particles of 14-16 BSS mesh (1.2-1.4 mm) size.

2.2. Thiocyanate sorption/uptake studies

A batch equilibration method was used to determine the sorption of thiocyanate using ground tree leaves. Biosorbent (1 g) was contacted with 50 ml thiocyanate solution having concentration of 100 mg/l of desired pH in a set of 150 ml capacity conical flasks. The contents of the flasks were stirred gently by sparging air using electrical aerator units and incubated at room temperature (30±2C) for 0.5 – 5 h. The contents of flasks were filtered and analysed for residual thiocyanate content.

In order to evaluate the effect of pH on biosorption of thiocyanate, 5 g of powdered biomass obtained from each plant/tree species was conditioned in DW at desired pH of 2, 3, 4, 5, 6, 7, 8, 9 and 10. Other experimental conditions were similar to those mentioned earlier. Thiocyanate loading capacity (mol thiocyanate bound per gram weight of biomass) of each biosorbent material was determined by contacting 1 g powdered biomass several times with fresh batches of 50 ml thiocyanate solution (100 mg/l) till the saturation was reached. These experiments were carried out at optimum pH value obtained for the respective biomass. For determining optimum biosorbent amount, 0.5 to 5% (w/v) sorbent was contacted with target

compound i.e. thiocyanate. Rate of thiocyanate uptake was studied by contacting the biosorbent for a period ranging 0 - 5 h. This experiment was carried out at optimum pH and biosorbent concentration. Other experimental conditions were similar to those mentioned earlier. All the experiments were performed in duplicates and repeated twice to confirm the results. Appropriate controls were run simultaneously to test the stripping of thiocyanate, if any, from solutions.

2.3. Glassware, chemicals and analyses

All the glassware used in the present study was made of borosilicate material. Chemicals used were of analytical grade. Potassium thiocyanate (KSCN) was obtained from Loba Chem, Mumbai. All the stock solutions and reagents were prepared in glass-distilled water (DW) and stored in refrigerator at 8-10°C. Thiocyanate in the liquid samples was estimated colorimetrically (Equiptronics, India) by ferric nitrate method as described in Standard Methods (APHA-AWWA-WEF, 1998). pH of the solutions were measured using pH meter (Equiptronics, India).

2.4. Adsorption isotherm models

Thiocyanate solutions of varying concentrations (ranging from approximately 1 to 17 mM, corresponding to approximately 50 to 1000 mg/l) were used to study the effect of initial thiocyanate concentration on it adsorption. The amount of thiocyanate sorbed at equilibrium, Q (mol/g), which represents the thiocyanate uptake, was calculated from the difference in thiocyanate concentration in the aqueous phase before and after adsorption, according to the following equation:

$$Q = \frac{V (C_i - C_f)}{1000\ m} \qquad (1)$$

Where, Q is the thiocyanate uptake (mol per gram biomass); V is the volume of thiocyanate solution (ml); C_i is the initial concentration (mg/l); C_f is the final concentration (mg/l); m is the mass of biosorbent (g).

To examine the relationship between sorbed and aqueous concentration at equilibrium, sorption isotherm models viz. Freundlich and Langmuir were used for fitting the data.

2.5. Freundlich adsorption model

The Freundlich model (Freundlich, 1926) habitually gives a better fit particularly for adsorption from liquids and can be expressed as:

$$\ln Q = \ln K + \frac{1}{n} C_{eq} \qquad (2)$$

Where, C_{eq} is the liquid phase concentration of thiocyanate; K is the constant; 1/n is the intensity of adsorption and Q is the specific metal uptake.

In this model, the mechanism and the rate of adsorption are functions of the constants 1/n and K. Many researchers have used this model to interpret their sorption data for various systems (Patil and Paknikar,1999).

2.6. Langmuir adsorption model

The Langmuir adsorption isotherm (Langmuir, 1918) is given by the following equation:

$$\frac{C_{eq}}{Q} = \frac{1}{bQ_{max}} + \frac{C_{eq}}{Q_{max}} \qquad (3)$$

Where, C_{eq} is the liquid phase concentration of thiocyanate; b is the Langmuir constant; Q is the thiocyanate uptake (mol/g biomass) Q_{max} is the maximum thiocyanate uptake.

In this model, Q_{max} (mg/g) is the amount of adsorption corresponding to complete monolayer coverage i.e. the maximum adsorption capacity. A host of research workers have applied this model to interpret their sorption data (Puranik and Paknikar, 1997).

2.7. Adsorption/Desorption of thiocyanate

Biosorbent (1 g) loaded with thiocyanate was eluted using 0.1 - 1 N sodium hydroxide (NaOH) in concentrated form and analysed. Following the elution, the biosorbent was washed with DW and then conditioned to appropriate pH to use it in next adsorption/desorption cycle. At each stage, one set was removed as a control.

Table 1: Biosorption of thiocyanate by waste biomass at optimum pH

Sr. No.	Biosorbent (Vernacular Name)	Q (mg thiocyanate sorbed per gram biomass)	Optimum pH for maximum sorption
1.	*Azadirecta indica* (Neem)	2.1	5, 6
2.	*Casurina* sp. (Suru)	2.0	5
3.	*Calycopteris floribunda* (Ukshi)	2.3	5
4.	*Eicchornia sp.* (Jalparni)	2.7	5, 6
5.	*Eucalyptus* sp. (Nilgiri)	1.8	5, 6
6.	*Artocarpus heterophyllus* (Jackfruit)	1.5	5, 6
7.	*Delonix regia* (Gold Mohar)	1.9	5, 6
8.	*Jambulana* sp. (Jamun)	2.4	5, 6
9.	*Lantana camera* (Ghaneri)	3.2	5, 6
10.	*Mangifera indica* (Mango)	3.8	4, 5, 6
11.	*Parthenium* sp. (Congress Grass)	2.7	5, 6
12.	*Tectona grandis* (Sag)	2.9	5, 6
13.	Activated charcoal*	4.6	4, 5, 6
14.	Fly ash*	1.4	6
15.	Saw dust*	2.8	4, 5, 6

All the values presented in table are average of two readings; *Reference materials used as control

3. Results

3.1. Screening of plant/tree biomass for thiocyanate sorption at optimum pH

The results obtained for thiocyanate sorption under optimal pH conditions are summarised in Table 1. It was observed that optimum sorption of thiocyanate (100 mg/l) for most of the sorbents tested were at pH 5.0 and 6.0 with the exception of *Casurina* sp. and *Calycopteris floribunda* biomass. For both the biomass, maximum sorption was observed only at pH 5. However, in case of *Mangifera indica* leaf biomass, activated charcoal and saw dust, pH optimum of 4 was also observed for thiocyanate sorption along with pH 5 and 6. For all the tested biomass, biosorption of thiocyanate did not take place above pH 6.0; while at pH below 4, sorption significantly decreased (data not shown). The table also shows that other than activated charcoal and saw dust (which were used as reference materials) biomass of *Mangifera indica, Lantana camera, Tectona grandis, Parthenium* sp. and *Eicchornia sp.* were efficient sorbents of thiocyanate. The Q values thus observed for these sorbents were in the range of 2.7 to 4.6 mg/g. The control flasks run simultaneously along with the experimental flasks showed no loss of thiocyanate.

On the basis of maximum thiocyanate uptake values (Q) obtained under optimum pH conditions, *Mangifera indica*, *Lantana camera, Tectona grandis, Parthenium* sp. and *Ecchornia* sp. were selected for further experiments on thiocyanate biosorption. Activated charcoal and saw dust were used as reference materials.

3.2. Thiocyanate loading capacity

Table 2 depicts the data on thiocyanate loading capacity of sorbent/biosorbents selected on the basis of maximum sorption under optimum pH. It is seen that *Mangifera indica* biomass had the maximum loading capacity for thiocyanate (10.5 mg/g) among the tested biomass; and was followed by *Lantana camera* (9.4 mg/g), *Parthenium* sp. (8.0 mg/g), *Ecchornia sp.* (7.8 mg/g) and *Tectona grandis* (7.1 mg/g). Loading capacity values of *Mangifera indica* biomass were comparable with activated charcoal (11 mg/g), which was used as reference material.

Table 2. Thiocyanate loading capacity of various biosorbents

Sorbent / Biosorbents	Loading capacity (mg/g of biomass)
Ecchornia sp.	7.8
Lantana camera	9.4
Mangifera indica	10.5
Parthenium sp.	8.0
Tectona grandis	7.1
Activated charcoal	11.0
Saw dust	9.5

All the values presented in table are average of two readings

Considering these results, selection of the biosorbent was further narrowed down to *Mangifera indica* leaf biomass for thiocyanate biosorption.

3.3. Influence of biosorbent/biomass quantity on thiocyanate biosorption

The effect of biomass quantity [% biomass in 50 ml thiocyanate solution (w/v)] on the thiocyanate biosorption was studied at room temperature (30±2°C) and at optimum pH of 5. Various amount of biomass like 0.5, 1, 1.5, 2.0, 2.5, 3, 4 and 5 g were used keeping the volume of thiocyanate solution constant i.e. 50 ml; thereby giving the solid-to-liquid ratio in the range of 0.01 to 0.1 and the results are shown in Fig. 1. The results indicate that as the biomass quantity increased the % biosorption of thiocyanate also increased. Maximum uptake (~87%) was observed at 3% (w/v) of *Mangifera indica* biomass quantity with 100 mg/l of thiocyanate. With 2% and 1% biomass amount, uptake decreased to 75% and 39%, respectively (Fig. 1).

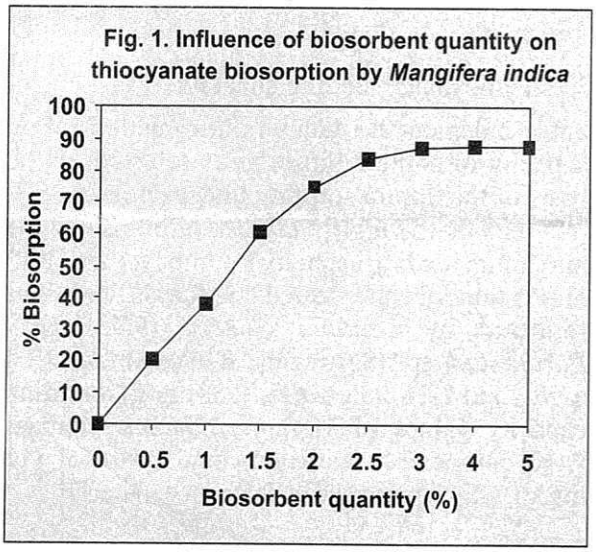

Fig. 1. Influence of biosorbent quantity on thiocyanate biosorption by *Mangifera indica*

3.4. Influence of contact time

The effect of contact time on thiocyanate biosorption was studied at optimum pH of 5, room temperature (30±2°C) and biomass quantity of 3% (w/v). 50 ml of thiocyanate solution having concentration 100 mg/l was contacted with 1.5 g of grinded *Mangifera indica* biomass for the period up to 300 min. The time intervals chosen to study the effect of contact time were 5, 10, 15, 20, 30, 40, 50, 60, 90, 120, 150, 180, 240 and 300 min. Periodically the flask content were removed by filtration and the filtrate were analysed for thiocyanate concentration. Curve in the Fig. 2 representing the kinetics of thiocyanate sorption showed that the rate of thiocyanate uptake was maximum in the first 20-30 minutes with over 60% of biosorption. Later, the sorption rate slowed down until it reached a plateau after 60 min, indicating equilibration of the system. Maximum sorption of thiocyanate observed at 60 min was 85% (Fig. 2).

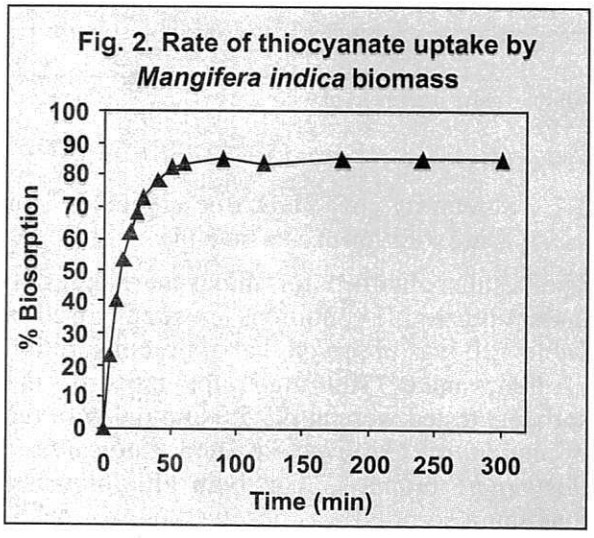

Fig. 2. Rate of thiocyanate uptake by *Mangifera indica* biomass

3.5. Adsorption isotherm models

The effect of initial concentration provides an important driving force to overcome all mass transfer resistance of target ion between the aqueous and solid phases. The biosorption of thiocyanate was carried out at different initial

thiocyanate concentrations ranging from 50 to 1000 mg/l (corresponding to approximately 1 to 17 mM) at pH 5.0 using 3% of ground *Mangifera indica* leaf biomass. Fig. 3 depicts the thiocyanate uptake by the ground *Mangifera indica* leaf biomass. It can be seen that the equilibrium sorption capacity of the sorbent increased with increasing initial concentration of thiocyanate from 50 to 1000 mg/l due to the increase in the number of ions competing for the available binding sites in the biomass. The uptake of thiocyanate by the sorbent reached a plateau at 700-800 mg/l. There was a significant increase in the specific uptake of thiocyanate upto 500 mg/l. Later the specific uptake of thiocyanate decreased with increased concentration. The specific uptake was 2 and 12 mg/g for thiocyanate concentration of 50 and 500 mg/l, respectively.

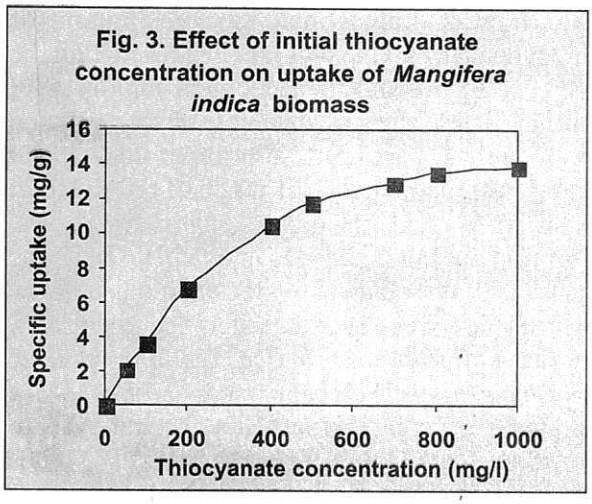

Fig. 3. Effect of initial thiocyanate concentration on uptake of *Mangifera indica* biomass

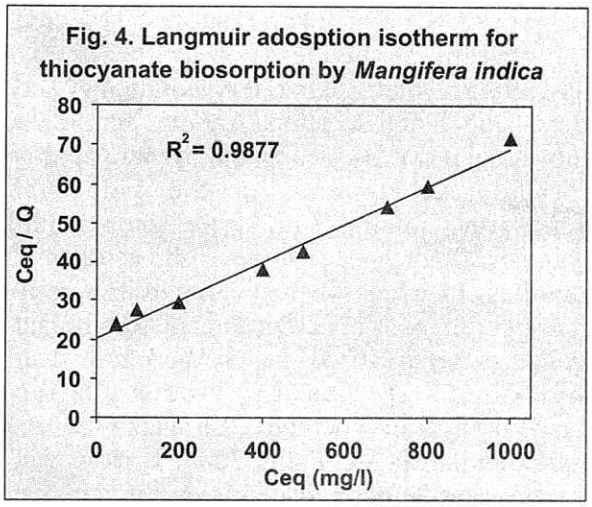

Fig. 4. Langmuir adosption isotherm for thiocyanate biosorption by *Mangifera indica*

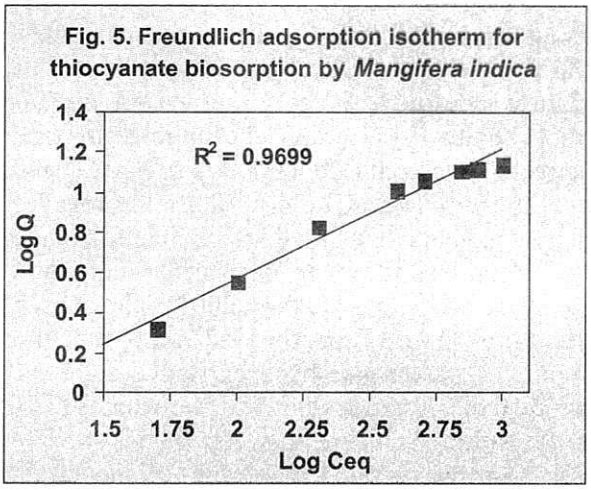

Fig. 5. Freundlich adsorption isotherm for thiocyanate biosorption by *Mangifera indica*

3.6. Equilibrium models to fit experimental data

To examine the relationship between sorption, isotherm models are widely employed for fitting the data. Langmuir and Freundlich models were used to describe the equilibrium between the thiocyanate sorbed on the ground *Mangifera indica* leaf biomass and thiocyanate ions in the solution. Fig. 4 and 5 show that thiocyanate uptake values could be fitted to the Langmuir and Freundlich isotherm models with the regression value of >0.96.

3.7. Adsorption-desorption of thiocyanate

The loaded thiocyanate could be desorbed with more than 90% efficiency using 0.1 - 1 M sodium hydroxide solution. Final concentrations of thiocyanate in the eluant were in the range of 800 to 1000 mg/l (14 to 18 mM) using *Mangifera indica* leaf biomass. These values represented an approximately 8 to 10 fold concentration of thiocyanate as compared to the original concentration of 100 mg/l (1.72 mM) that was used for sorption. However, during the second cycle of thiocyanate adsorption, the loading capacity of the biosorbent decreased by 35-40%.

4. Discussion

Biosorption of heavy metal cations from aqueous solutions have been studied extensively by several researchers world wide (Modak and Natrajan, 1995; Paknikar *et al.*, 2003). A number of research papers have also been published on the sorption and removal of anionic metal species like chromates (Basha *et al.*, 2008), free cyanide (Azab *et al.*, 1995) and metal-cyanides (Patil and Paknikar, 1999) using microbial

biomass (especially fungal cultures) procured either from fermentation industry or by cultivating it under laboratory conditions and then using it for sorption. Another important known chemical species is 'thiocyanate' that is normally encountered in the industrial wastewaters along with free- and metal-cyanides. Thiocyanate is one of the active and important members of the cyano-group family that occur in the water environment. Significant work has been carried out on the removal of thiocyanate species by biodegradation /biodetoxification method (Karavaiko *et al.*, 2000; Patil, 2008a; Patil, 2008b). However, scanty information is available on the removal and recovery of anionic species like thiocyanate using sorption technology from aqueous wastes. Much of the work carried out previously is mainly confined to the removal of metal-thiocyanates using anion exchange resins and activated charcoal (Kononova *et al.*, 2007) and polyurethane foam (Hasany, 2002). Removal of metal-thiocyanate using low-cost materials like agricultural solid waste has been reported in recent times (Namasivayam, 2007). The overall literature review clearly indicates that no significant work has been carried out on the removal of anionic species like thiocyanate from waste solutions using low-cost materials like plant biomass. Since all the cyano-group chemicals like free cyanide and thiocyanate, metal-cyanides and metal-thiocyanates are toxic to all classes of living organisms their removal from waste prior to discharge in the environment becomes the key.

In the light of the above background, the core objective of the present research work was to study the feasibility of biological removal and recovery of thiocyanate from aqueous industrial waste solutions for possible recycling in the industry using ground waste leaves obtained from various photosynthetic trees. It was thought that, if an efficient process for removal/recovery could be developed, thiocyanate could be conserved, which in our opinion would be a novel approach of resource recovery. Free cyanide and thiocyanate, metal-cyanides and metal-thiocyanates can occur in the waste waters in various forms depending upon the chemical nature of the compounds and the concentration of metal, cyanide and thiocyanate, provided the metal moiety is bound to cyanide and thiocyanate. For example, free cyanide and thiocyanate can occur in the waters in its anionic form like CN^- and SCN^-, respectively. Therefore, it was thought worthwhile to explore the possibility of their recovery by adsorption on low-cost material like ground plant leaf biomass procured from various photosynthetic trees. Known sorbents such as activated charcoal, saw dust and fly ash were used for obtaining comparative data.

It is well known that the process of biosorption is governed by the solution pH (Puranik and Paknikar, 1997). For this reason, the first selection step used during the present studies was determination of optimum solution pH. It was found that the biosorption of thiocyanate by all the biomass increased with the increase in pH and then declined rapidly with further increase in pH (data not shown). As seen from Table 1, maximum sorption of thiocyanate could take place in the pH range of 5.0 to 6.0 in most cases; and pH 4.0 to 6.0 in few cases. Sorption did not take place above pH 6.0. It was found that other than activated charcoal and saw dust (which were used as reference materials), biomass of *Mangifera indica*, *Lantana camera, Tectona grandis, Parthenium* sp. and *Ecchornia* sp. were efficient biosorbents for thiocyanate sorption. The Q (i.e. specific uptake) values observed for these sorbents were in the range of 2.7 to 4.6 mg/g. There was no loss of thiocyanate in the control flasks (flasks devoid of any biosorbent) confirming that biosorption is the only mechanism by which thiocyanate is being removed from the aqueous solution. Previous studies carried out by Namasivayam (2007) found that the optimum pH for maximum adsorption of thiocyanate by modified coir pith (an agricultural waste) was 2.0; while Lazaridis (2003) has reported a pH optimum of 7.0 - 7.5 using hydrocalcite-500.

The increase in sorption of thiocyanate in acidic conditions may be due to the protonation of biosorbent surface (i.e. the functional groups) acquiring net positive charges. Therefore, probably the formation of species such as HSCN on the biomass might have taken place. Thus, relatively more thiocyanate species could have accommodated on the biosorbent sites. Leaves from the plant biomass are well known to contain large number of surface functional groups viz. hydroxyl, carbonyl, carboxyl, sulphydryl,

amine, imine, amide, phosphonate, phosphodiester, etc (Basha *et al.*, 2008; Gardea-Torresdey *et al.*, 1998). Probably some of these functional groups might have played the role in the sorption of thiocyanate from aqueous solution. It is known that the pH dependence of cations and anionic adsorption can largely be related to type and ionic state of these functional groups and also the chemistry of target compound in solution (Matheickal and Yu, 1996). Thiocyanate, although a non-metal and anionic chemical species, could be compared with anionic metal species like hexavalent chromium (an oxyanion). At low pH values, cell wall ligands are protonated and compete significantly with metal binding. With increasing pH, more ligands such as amino and carboxyl groups, would be exposed leading to attraction between these negative charges and the metals and hence increases in biosorption on to cell surface (Aksu, 2001). As the pH increased further, the overall surface charge on the cells could become negative and biosorption decreased (Aksu, 2001). Patil and Paknikar (1999) have reported the optimum pH of 4.0 for the sorption of metal-cyanides from aqueous solutions using *Cladosporium cladospoiroides* biomass.

It is worthwhile to mention that HCN gas is not formed under acidic conditions (as it happens easily in case of free cyanide i.e. KCN/NaCN and up to certain extent in metal-cyanides) because SCN^- is known to have high stability under acidic conditions (APHA-AWWA-WEF, 1998). Biosorption, therefore, under acidic conditions would be a safe procedure. Cyanide and thiocyanate containing industrial wastewaters generally have pH ranging from 5.5 to 12.5. Obviously, appropriate pH adjustments of the effluents will have to be carried out prior to biosorption. On the basis of maximum thiocyanate uptake values obtained under optimum pH conditions, *Mangifera indica*, *Lantana camera, Tectona grandis, Parthenium* sp. and *Ecchornia* sp. were selected for further experiments on thiocyanate biosorption. Activated charcoal and saw dust were used as reference material.

The thiocyanate loading capacity of the biosorbent could be taken as an equivalent measure of binding sites present. It could be seen that *Mangifera indica* biomass had the maximum loading capacity for thiocyanate (10.5 mg/g) among the tested biomass; and was followed by *Lantana camera* (9.4 mg/g), *Parthenium* sp. (8.0 mg/g), *Ecchornia sp.* (7.8 mg/g) and *Tectona grandis* (7.1 mg/g). Loading capacity value of *Mangifera indica* biomass was comparable with activated charcoal (11 mg/g); which opens up new possibilities of developing an efficient bisorption technology for the recovery of anionic speceis like thiocyanate and other similar species from wastewaters. In the previous study by Patil (1999), it was found that the biomass of *Cladosporium cladosporoides* had higher loading capacity (34 - 40 µmol/g) than activated charcoal (27.5 - 30 µmol/g) for the sorption of metal-cyanides viz. copper- and nickel-cyanide. This result clearly indicates that more such programmes for biomass screening should be carried out in search for the right candidate for efficient sorption. Considering the results from our experiments on powdered plant leaf biomass, selection of the biosorbent was further narrowed down to *Mangifera indica* leaf biomass for thiocyanate biosorption.

For the cost-effective treatment of industrial wastewaters for thiocyanate removal, it is necessary to know the biomass quantity (i.e. solid-to-liquid ratio) required. In our experiments, it was found that as the biomass quantity increased the percentage biosorption of thiocyanate also increased. Maximum uptake (~87%) was observed at 3% (w/v) of *Mangifera indica* biomass quantity with 100 mg/l of thiocyanate giving the solid-to-liquid ratio of 0.03. With 2% and 1% biomass amount, uptake decreased to 75% and 39%, respectively (Fig. 1). However, as the concentration of biomass was further increased the thiocyanate sorption did not increase but remained constant. No specific thiocyanate uptake at increased biomass loading is attributable to the interference between binding sites at higher quantities (deRome and Gadd, 1987).

The process of sorption/biosorption is essentially a surface interaction and is characterised by rapid uptake of ions by biomass surfaces. Rapidity of the process makes it a good candidate for use in effluent treatment on a large scale. Kinetics of thiocyanate sorption showed that the rate of thiocyanate uptake was more in the first 20-30 minutes with over 60% of biosorption. Later, the sorption rate slowed

down until it reached a plateau after 60 min, indicating equilibration of the system. Maximum sorption of thiocyanate (up to 85%) was observed at 60 min (Fig. 2). The rapid kinetics has significant practical importance as it will facilitate smaller reactor volumes ensuring efficiency and economy.

The effect of initial thiocyanate concentration on biosorption by ground *Mangifera indica* leaf biomass showed that the equilibrium sorption capacity of the sorbent increased with increasing initial concentration of thiocyanate from 50 to 1000 mg/l. This was due to the increase in the number of ions competing for the available binding sites in the biomass. Uptake of thiocyanate at various concentrations reached a plateau when the concentration was in the range of 700 to 800 mg/l. This might be due to the saturation of binding sites, which clearly showed that thiocyanate uptake by *Mangifera indica* biomass was a chemically equilibrated and saturable phenomenon. The higher initial concentration provides increased driving force to overcome all mass transfer resistance of target chemical ions between the aqueous and solid phases resulting in higher probability of collision between thiocyanate ions and the sorbent. This results in higher uptake of the target compound. Moreover, biomass cell membranes contain polysaccharides as basic building blocks, which have ion exchange properties, and also proteins and lipids and therefore offer a host of functional groups capable of binding to thiocyanate ions.

Biosorption of target ions (both cations and anions) is a dynamic process. Immediately after contact of biosorbent with the target compound solution, the rate of sorption (forward reaction) is very high as compared to the rate of desorption (backward reaction). Sorption slows down as binding sites are progressively occupied, until the rates of both the forward and backward reactions are exactly balanced. At this point the biomass is saturated with target ions and no net uptake of these ions occurs. Biosorption resembles physical adsorption process and follows an adsorption type isotherm (Tsezos, 1990). Adsorption isotherms are the plots of solute concentration in the adsorbed state as a function of its concentration in the solution at constant temperature. Equilibrium sorption isotherms give valuable information for selection of an adsorbent and facilitate evaluation of adsorption process for a given application (Weber, 1985). The isotherm indicates the relative affinity of biosorbent for target ions and the adsorption capacity of biosorbent. Also, the sensitivity of biosorption changes in target compound concentration can be determined by the relative steepness of the isotherm line. Important equilibrium models developed to describe adsorption isotherm relationships include single layer adsorption (Freundlich, 1926; Langmuir, 1918) and multilayer adsorption (Branauer *et al.*, 1938).

Langmuir (1918) developed this model on the assumptions that: (i) Adsorption energy is constant and independent of surface coverage; (ii) Adsorption occurs on localised sites with no interaction between adsorbate molecules; and (iii) Maximum adsorption occurs when the surface is covered by a monolayer of adsorbate. The Freundlich (1926) isotherm model is originally empirical in nature, but was later interpreted as sorption to heterogeneous surfaces or surfaces supporting sites of varied affinities and has been used widely to fit experimental data (Patil, 1999; Puranik, 1998). It is assumed that the stronger binding sites are occupied first and that the binding strength decreases with the increasing degree of site occupation.

Despite the complexity of the adsorption process, which can include several mechanisms, adsorption isotherms have been used to characterise target compound uptake and they appear to be of use for projected industrial applications (Tsezos and Volesky, 1981). Hence, it was decided to fit the available thiocyanate sorption data with two most widely accepted adsorption models, viz. Freundlich and Langmuir. Linear transformation of the adsorption data using Freundlich and Langmuir models ($R^2 = >0.96$) allowed computation of the thiocyanate adsorption capacities. Experimental data obtained in the studies were found to obey basic principles underlying these models, that is, heterogeneous surface adsorption and monolayer adsorption at constant adsorption energy respectively (Freundlich, 1926; Langmuir, 1918).

Recovery of target compound from industrial effluents is desirable when the target compound is costly and rare. Although the concentration of target compounds in the effluents may not be

very high (< 25 – 50 mg/l), the total amount of target compound may be quite significant considering the large volumes of effluent generated daily. For an effective and viable biosorption technology, elution methods for the recovery of target compound should be highly efficient, economical and should not cause damage to the biomass. Several eluting agents have been reported in the literature which include mainly mineral acids, alkalis, organic acids, etc. In the present studies on sorption/desorption the loaded thiocyanate on *Mangifera indica* leaf biomass could be desorbed with more than 90% efficiency using 0.1 - 1 M sodium hydroxide solution. Final concentrations of thiocyanate in the eluant were in the range of 800 to 1000 mg/l (14 to 18 mM). These values represented an approximately 8 to 10 fold concentration of thiocyanate as compared to the original concentration of 100 mg/l (1.72 mM) that was used for sorption. Such highly concentrated solution of recovered thiocyanate may be recycled in the user industry. Thus, it can be concluded that natural waste biomass (like dried leaves of photosynthetic plants) has immense potential "as biosorbents" for the removal/management of variety of industrial pollutants, as evident from the example of thiocyanate management in the present study. Further, biosorption technology used could also become an economical, non-destructive and reliable alternative to the conventional processes for the management of industrial effluents employed on the commercial scale.

Management of industrial pollutants in the 21st century is completely changing its face and orientation. In the present day scenario, a pollutant is no way considered as a pollutant or waste but is rather regarded as a 'resource' that could be recovered or extracted from the effluents using suitable technologies. Therefore, in a real sense, concepts like reuse, recycle and recovery of waste materials are gaining remarkable importance in today's so called Technological Society. Applications of concepts similar to this work will ultimately reduce/minimize the demand for natural resources by the industries, thereby increasing their overall profit margin and prolonged sustenance of both natural and manmade resources. In this regard, the present research work is an advancement of knowledge in the field of resource management, waste minimization, pollution management and help profitability of business community at large.

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References

Aksu, Z. (2001) Equilibrium and kinetics modeling of cadmium (II) biosorption by *C. vulgaris* in a batch system: effect of temperature. *Separation and Purification Technology* 21: 285-294.

American Public Health Association, American Waste Water Association, Water Pollution Control Federation (1992) *Standard Methods for the Examination of Water and Wastewater*, 18th edn. Washington, DC.

Azab, H.M., El-Shora H.M. and Mohammed, H.A. (1995) Biosorption of cyanide from industrial waste water. *Al-Azhar Bulletin of Science* 6: 311-323.

Basha, S., Murthy, Z.V.P. and Jha, B. (2008) Biosorption of hexavalent chromium by chemically modified seaweed, *Cystoseira indica*. *Chemical Engineering Journal* 137: 480-488.

Beekhuis, H.A. (1975) *Technology and Industrial Application* In: Newmann, A.A., Chemistry and Biochemistry of Thiocyanic Acid and its Derivatives, Academic Press, London.

Boening, D.W. and Chew, C.M. (1999) A critical review: General toxicity and environmental fate of three aqueous cyanide ions and associated ligands. *Water, Air and Soil Pollution* 109: 67-79.

Braunauer, S. *et al* (1938) Adsorption of gases in multimolecular layers. *Journal of American Chemical Society* 60: 309-319.

Brown, P.D. and Morra, M. J. (1993) *Journal of Agriculture and Food Chemistry* 41: 978.

De Rome, L. and Gadd, G.M. (1987) Copper adsorption by *Rhizopus arrhizus, Cladosporium resinae* and *Penicillium italicum*. *Applied Microbiology and Biotechnology* 26:84-90.

Freundlich, H. (1926) *Colloid and Capillary Chemistry*. London: Methuen.

Ganczarczyk, J.J., Takoaka, P.T. and Ohashi, D.A. (1985) Application of polysulfide for pretreatment of spent cyanide liquors. *Journal of Water Pollution Control Federation* 57:1089-1093.

Gardea-Torresdey, J.L., Hernandez, A., Tiemann, K.J., Bibb, J. and Rodriguez, O. (1998) Adsorption of toxic metal ions from solution by inactivated cells of *Larrea tridentate* (Creosote Bush). *Journal of Hazardous Substance Research* 1: 3.1-3.16.

Hasany, S.M., Saeed, M.M. and Ahmed, M. (2002) Sorption and thermodynamic behaviour of zinc(II)-thiocyanate complexes onto polyurethane foam acidic solutions. *Journal of Radioanalytical and Nuclear Chemistry* 252(3): 477-484.

Ho, S.P., Wang, Y.Y. and Wan, C.C. (1990) Electrolytic decomposition of cyanide effluent in an electrochemical reactor packed with stainless steel fibre. *Water Research* 24:1317-1321.

Hughes, M.N. (1975) *General Chemistry* In: Newmann, A.A., ed., Chemistry and Biochemistry of Thiocyanic Acid and its Derivatives, Academic Press, London.

Karavaiko, G.I., Kondrat'eva, T.F., Savari, E.E., Grigor'eva, N.V. and Avakyan, Z.A. (2000) Microbial degradation of cyanide and thiocyanate, *Microbiology*, 69(2):167-173.

Kenfield, C.F., Qin, R., Semmens, M.J. and Cussler, E.L. (1988) Cyanide recovery across hollow fibre gas membranes. *Environment Science and Technology*. 22:1151-1155.

Kononova, O.N., Kholmogorov, A.G., Danilenko, S.V., Kachin, S.V., Kononov, Y.S. and Dmitrieva, Z.V. (2005) Sorption of gold and silver on carbon adsorbents from thiocyanate solutions. *Carbon* 43(1): 17-22.

Langmuir, J. (1918) The adsorption of gases on plane surfaces of glass, mica and platinum. *Journal of American Chemical Society* 40: 1361-1403.

Lazaridis, N.K. (2003) Sorption removal of anions and cations in single batch systems by uncalcined and calcined Mg-Al-CO_3 hydrotalcite. Water, Air and Soil Pollution 146: 127-139.

Matheickal, J.T. and Yu, Q. (1996) Biosorption of lead from aqueous solutions by marin alga *Ecklonia radiate*. *Water Science and Technology* 34: 1-7.

Modak, J.M. and Natarajan, K.A. (1995) Biosorption of metals using nonliving biomass – A review. *Mineral and Metallurgy Process* 12: 189-196.

Mudder, T.I. and Whitlock, J.L. (1984) Method for the biological removal of free and complex cyanides and thiocyanates from water. US Patent No. 4,440,644 (to Home Stake Mines).

Namasivayam, C. and Sangeetha, D. (2005) Kinetic studies of adsorption of thiocyanate onto zinc chloride activated carbon from coir pith, an agricultural solid waste. *Chemosphere* 60(11): 1616-1623.

Paknikar, K.M., Pethkar, A.V. and Puranik, P.R. (2003) Bioremediation of metalliferous wastes and products using inactivated microbial biomass. *Indian Journal of Biotechnology* 2: 426-443.

Patil Y.B. (1999) *Studies on Biological Detoxification of Metal-Cyanide Containing Industrial Effluents.* Ph.D. Thesis, University of Pune, Pune, India.

Patil, Y.B. and Paknikar, K.M. (1999) Removal and recovery of metal cyanides by using a combination of biosorption and biodegradation processes. *Biotechnology Letters* 21: 913-919.

Patil, Y.B. and Paknikar, K.M. (2000) Development of a process for biodetoxification of metal cyanides from waste waters. *Process Biochemistry* 35:1139-1151.

Patil, Yogesh B. (2008a) Degradation of thiocyanate from aqueous waste by a mixed bacterial community. *Research Journal of Chemistry and Environment* 12(1): 69-75.

Patil, Yogesh B. (2008b) Thiocyanate degradation by pure and mixed bacterial cultures. *Bioinfolet: Journal of Life Sciences* 5(3): 308-309.

Puranik, P.R. (1998) *Studies on Removal and Recovery of Metals from Industrial Effluents.* Ph.D. thesis, University of Pune, Pune.

Puranik, P.R. and Paknikar, K.M. (1997) Biosorption of lead and zinc from solutions using *Streptoverticillium cinnamoneum* waste biomass. *Journal of Biotechnology* 55:113-124.

Stratford, J., Dias, A.E.X.O and Knowles, C.J. (1994) The utilization of thiocyanate as a nitrogen source by a heterotrophic bacterium: the degradative pathway involves formation of ammonia and tetrathionate, *Microbiology* 140: 2657-2662.

Teo, W.K. and Tan, T.C. (1987) Hypochlorite oxidation of cyanate under mildly alkanline conditions. *Water Research* 21:677-682.

Tsezos, M. (1990) Engineering aspects of metal bonding by biomass. In: *Microbial Mineral Recovery*, edited by H.L. Ehrlich and C.L. Brierley. McGraw-Hill Publishing Co., New York, USA, pp. 325-339.

Tsezos, M. and Volesky, B. (1981) Biosorption of uranium and thorium. *Biotechnology and Bioengineering* 23:583-604.

Weber, W.J. Jr. (1985) Adsorption theory, concepts and models. In: *Adsorption Technology: A Step-By-Step Approach to Process Evaluation and Application*, edited by F.L. Slejko, Marcel Dekker, New York. pp. 1-35.

Whitlock, J.L. (1990) Biological detoxification of precious metal processing wastewaters. *Geomicrobiology Journal* 8:241-249.

Impacts of Watershed Development Projects Management Through Labour and Machines: A Comparative Study of Two Villages In Maharashtra

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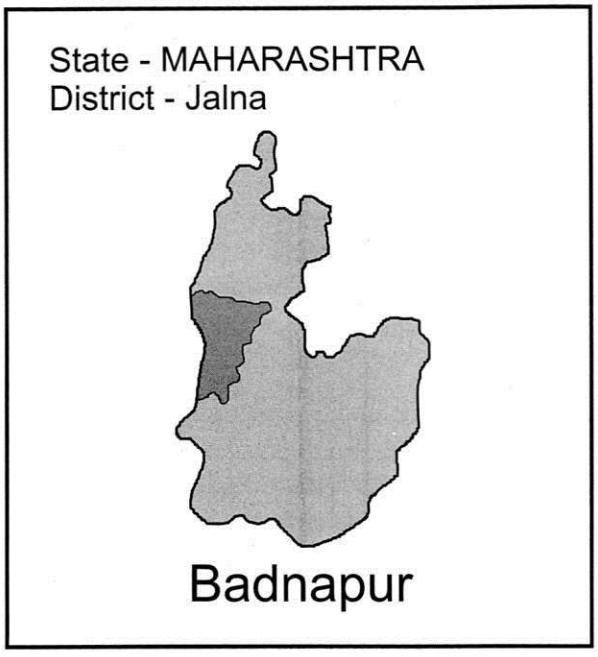
Abstract

Sustainable management of watersheds through soil and water conservation and conservation of other natural resources have been given high priority in many countries in the world for the last several decades. Especially in countries like India, where there is shortage of water for irrigation and the overall irrigation potential cannot irrigate a good amount of agricultural land, the policies like integrated watershed management have been regarded as a suitable approach to address issues of agriculture productivity, poverty and food security of populations. In India the available irrigation potential cannot help irrigate more than 40 per cent of India's agriculture, the programmes like watershed development through the soil and water conservation are significant for Indian agriculture. The encouraging experience from the ongoing watershed development programmes for drought proofing of rain-fed agriculture by conserving land and water resources underlines its significance. The Eleventh Five Year Plan targeting 8.5 per cent of annual growth with 10 per cent for the last two years plus 4 per cent of growth of agriculture with inclusion of all, particularly the rural masses, also expects watershed programmes to become one of the instruments of achievement. The present economic plan making provision of expenditure for 24 lack crore on various programmes for achievement of targeted growth sees, according to the recent guidelines, the watershed development programme as one of the instruments for inclusiveness of community with decentralized implementation for generating rural employment and removal of poverty by way of increasing levels of income of rural people. The single most important factor accounting for positive impact of this programme is community participation and decentralization of programme administration made possible under the new guidelines. The coverage needs to expand through increased outlays, as only about 25 per cent of degraded land and less than that of the dry land in the country is estimated to have been treated so far. As far as the mode of implementation of the watershed development programme is concerned, there seems much controversy between the advocacy of machine and manual labour. This needs adequate and unbiased research, which exactly is the area that has been lacking in the Indian context. The existing public outlay on agricultural research and education stagnating around 0.5 per cent of agricultural GDP in the country is too meager and needs to be stepped up substantially. The controversies arising out of the mode of implementation are certainly in contrast with the objectives and philosophy of the programme and it can mislead the policy domain. The present paper attempts to address the controversy by comparing the outcomes of the watershed programmes implemented through machine in one and manual labour in the other village. The study advocates that the pre-project situation, level of community awareness and development vision of the village must be the basis for deciding mode of implementation of watershed project rather than merely availability of labour in the village.

Keywords: Groundwater, Water Charges, Water Conservation, Water Depletion, Water Percolation, Water Resources, Water Table, Water Users, Watershed, Watershed Intervention, Well-irrigation

1. Introduction

Watersheds in the Indian context have come to be acknowledged as key and discrete units in rural development. Integrated Watershed Development Programmes have clearly established that they are the important vehicle to achieve the objectives of: 1) increases in production and availability of food, fodder and fuel, 2) restoration of agro ecological balance and, 3) in improving the livelihood status of the village communities. The intensification and diversification of production systems in watersheds has to be viewed from a livelihood perspective. For sustainable livelihoods, the trade off between productivity, equity and sustainability is critical.



Various collaborative watershed development projects have been implemented in India, involving Government and NGO partners in many states, Maharashtra being a pioneer in the sector. Watershed interventions are mainly soil conservation measures, forestry and horticulture plantations, agronomic practices and water harvesting structures.

The entire area of the watershed is treated with soil and stone structures. Largely, watershed development comprises of land-based activities such as bunding, trenching, stone and earthen plugging. All these activities require manual labour and/ or machines to actualize.

1.1. Research Question

The research problem arises from the two contradictory situations as mentioned below existing at the same time in rural development sector in Maharashtra state.

Situation A:

- Prime Minister announced Vidarbha Package to control the farmers' suicides in the region. Under the package, GoM and NABARD undertake watershed works to provide employment to people, to increase the crop productivity and thus incomes of the farmers in the region.
- Under NREGS, Government decided to undertake mostly the soil and water conservation works so as to provide employment to people.

Situation B:

- Gramsabha of one of the watershed villages in Aurangabad district in Maharashtra state passed a resolution in suggesting use of JCB machine in place of labourers to undertake watershed works.
- NABARD suggests that machines might be used for implementation of watershed works if Gramsabha (Village parliament) resolves so due to non- availability of labourer in the village.
- GoM Watershed Mission guidelines promote use of eco-friendly machineries in case people don't come as manual labour for certain soil and water conservation works in watershed.

Several questions arise in mind when one understands the dynamics of the above situations. Few of them are mentioned below.

- What are policies/ opinions of government and non- government agencies with regard to use of machines in watershed? What does the community and CBOs in general and poor section in particular say about the issue?
  - Is it true that labour availability in villages for undertaking watershed works is drastically reduced? If yes,
  - Is it linked with the wages they get for such hard works?
  - Is it related to the work environment/ situation provided to labourer such as baby care, drinking water availability, tools availability, toughness of works, working time and other factors?
  - Is the community sufficiently mobilized to undertake watershed works as their own development? Are they aware about the possible benefits of the watershed development?
  - Is it true that labour unavailability is the only reason for promoting machinery? Are there other factors influencing the use of machinery such as spending targeted budget?
- What are the benefits and drawbacks of using machinery for watershed works experienced by the community? (Also bullock drawn machines)

- What about distribution of benefits within the community? Is it equitably distributed among poor and better-off sections?

The key research question therefore emerges as:

In what way and to what extent do, the impacts/ benefits differ when manual labour and machines are used to execute watershed works?

2. Methodology

The research has focused on a comparative study of processes and impacts of watersheds implemented with the help of labour force on the one hand and machinery on the other. Thus two different watershed villages were required to be selected to undertake the present study. There are a large number of watersheds implemented though labour force, but not many watersheds programmes have been implemented by using machinery in Maharashtra. There are a few watersheds in Beed, Osmanabad and Latur districts under government monitoring and three watersheds in Jalna district under NGO supervision that are implemented largely by using machinery. In these districts, there also exist a number of watersheds implemented by government and NGOs. The sample watershed villages are identified based on following criteria:

- Two separate watershed villages are selected; one implemented by using labour force while another by using machinery.
- Both the watershed villages must have maximum similarity in socio-technical and cultural aspects/ situation so that these factors affect equally on research variables.
- Both the watersheds must have been implemented under the similar programme guidelines and institutional framework. That means both of them are supported either by government alone or NGO so that there is no difference in implementation style/ philosophy. But within these two types, watershed implemented either by two different government agencies or by two different NGOs can be selected.
- Selected watersheds must have similar recognition in the taluka/district in terms of its success or impacts. That means we may not select one watershed with excellent impacts and other with negligible impacts.

Secondary data collected on name, type, programme, implementation status and success rating was scrutinized to identify the following two watershed villages that fulfill above mentioned criteria.

(i) Nandkheda, Taluka Badnapur Dist. Jalna implemented by Nirman Gramin Vikas Sanstha based at Aurangabad under IGWDP-Maharashtra. All the area treatments in this village are done completely by using manual labour from the village. Tractor was used to transport materials required for certain structures, especially drainage line treatments.

(ii) Asarkheda, Taluka Badnapur Dist. Jalna implemented by Marathwada Sheti Sahayya Mandal (MSSM), Aurangabad (Marathwada Agriculture Assistance Group) under IGWDP-Maharashtra. About 70% of the area treatments in this village are done by using machine such as bulldozer, scraper and tractor. Thus Asarkheda is considered as machine watershed for the purpose of the present study.

2.1. Household Sampling

Within the selected watershed villages, a minimum 10 % of total households are selected for household level interviews. Random sampling method was used to select the households to be interviewed. The total number of households in Nandkheda is 185 (census 2001) out of which 22 households (almost 12%) participated in the study. In case of Asarkheda out of 260 (census 2001), 24 households (little less than 10%) participated in the study.

2.2. Key Stakeholders Sampling

Concerned community organizations in the selected watershed villages such as GramPanchayat, Watershed Committee, Women's SHGs and Samyukt Mahila Samittee (SMS) (Combine women's committee) were interviewed separately or collectively as per the site situation.

- A few officials and head of the implementing organizations concerned with the selected watershed villages were interviewed separately and collectively as per the site situation. The study used data and information from both secondary and primary sources. Data was collected at the level of the watershed/

village level (also in-turn at the household level) and state level. The following tools were used to collect the data required and to facilitate the discussions.

- Focus Group Discussions with members of Gram-Panchayat, Watershed Committees and other community organizations
- Key Stakeholder Interviews with watershed experts and concerned project level officers
- Household Questionnaire for carrying out field surveys
- Observational field monitoring to assess quantity and quality of technical treatments.
- Relevant data/information was also obtained from secondary sources such as NGO records, past research studies, project completion and evaluation reports, watershed guidelines, schemes, etc.

Both the watershed projects were completed by two separate NGOs having varied experience in development sector. MSSM has been in this field since the 1960s while Nirman is relatively a new NGO that started its operations 13 years back. As a part of IGWDP, both the projects were having feasibility study reports (FSR) prepared during the first year of implementation. FSR provided very detailed baseline data with regard to population, area, crops, irrigation facilities and livestock along with proposed watershed treatments with the budget. The project completion report (PCR) was another document used for secondary data collection and it provided authorized data (accepted by NABARD) on interventions, investments, preliminary impacts and details of project activities, institutions and maintenance fund.

3. Discussion

3.1. Background of study villages

The study villages are major villages involved in their respective watershed projects implemented under IGWDP. Both the villages are situated in Badnapur taluka of Jalna district. The study is limited to Nandkheda and Asarkheda villages as these are the major villages in their respective watershed projects. The project investment data is not available separately for Nandkheda and Asarkheda and hence it indicates the watershed as a whole.

Nandkheda watershed consists of Nandkheda, Rajewadi, Bhakarwadi and part of Marsavali village. Nandkheda village is situated about 60 km from Jalna and 55 km from Aurangabad. The village has primary school till seventh standard. The school is well maintained by the villagers in terms of facilities for children and quality of education. Most students go to Bhakarwadi which is 2 km away for education up to 10th standard. After 10th, they have to go to Takali village for 11-12 standards, about 6 km away. University education facilities are available only at Fulambri (35km) and Aurangabad (55 km). A sub-center of primary health centre (PHC) is based in the village itself while PHC is at Dabhadi- 15 km away. It is linked with the banking facilities either to Dabhadi or Gevrai (60km by tar road). Water supply scheme provides drinking water to the villagers. A separate Gram Panchayat exists in the village and is currently led by a woman sarpanch. The village is also represented in taluka panchayat samittee by a woman. Village watershed committee of 27 members is registered in the name of Savaleshwar Krishi va Gram Vikas sanstha under Society's act. A temple committee and 15 women SHGs led by Samyukt Mahila Samittee (SMS) are also functional in the village. SMS and SHGs deal with credit business with banks and other MFIs.

Asarkheda watershed consists of three villages namely Asarkheda, Dongaon and small part of Tupewadi. Asarkheda village is situated at 22 km from Jalna- the district place. The education facility till seventh standard is available in the village itself. Thereafter the students go to Dongaon, which is merely 1.5 km away. PHC sub-center is situated in the village. Banking facilities are accessed from Jalna city. The villagers have drinking water supply scheme functional since 1989. Many village institutions exist in the village. Gram Panchayat (7 member), Rushi maharaj Sansthan (8 member), Jai yogeshwar library, Asarkheda watershed committee, 6 women SHGs, 2 mahila mandals, 3 men SHGs and a bhajani mandal are worth mentioning. Bawane pangri based multi-purpose credit cooperative society has 175 members from Asarkheda with one elected representative on director board out of total 9 members.

The following tables indicate the various data

collected by the project implementing agencies during the year 1995-96 and sourced from Feasibility Study Reports of respective projects sanctioned by NABARD under IGWDP.

Table 1 reveals the demographic details of both the watersheds in terms of caste and gender compositions as well as education status at the time of the start of the project. The majority of community members, 60-70% in both the watersheds, are Maratha while rest of the population belongs to SC, ST and NT. Table 1 shows that the gender ratio in both the watersheds was unfavorable to women with Asarkheda (933) in quite better condition than Nandkheda (827).

Nandkheda while the SC population in Asarkheda was 45 and that of ST it was 16 (8%). The literacy rate was 52.4% and 59.2% in Nandkheda and Asarkheda, respectively.

Table 2 shows land details in terms of area of private and public land that is included in watershed project. The project total indicates area confined by watershed boundary while next column indicates area confined by revenue boundary of Nandkheda and Asarkheda villages. The project total is important to know because entire interventions/ investments are based on this data.

Proportion of public/community land to the total geographic area of watershed is 20% in

Table 1: Demographic and Educational Background of the Villages*

	Nandkheda	Percent	Asarkheda	Percent
Total Households	**256**	100%	**212**	100%
Scheduled Caste	21	8%	45	21%
Scheduled Tribes	18	7%	16	8%
Nomadic Tribes	57	22%		0%
Others (Maratha)	160	63%	151	71%
Total Population	**1619**		**1245**	
Male population	886		644	
Female population	733		601	
Gender ratio- Female/1000 Male		**827**		**933**
Education	**1201**	100%	**418**	100%
Read and write only	611	51%	37	9%
Primary	247	21%	270	65%
Secondary	234	19%	92	22%
Matriculate	64	5%	16	4%
Graduate and above	45	4%	3	1%

* Village Census 2001.

Jalna district is ranked lowest among the districts in Maharashtra in HDI due to lower educated population. Table no. 1 brings out the fact that even among the educated, about 73% could only know reading and writing, maximum 5% reach matriculation and merely 1-4% reaches for university level education. Asarkheda shows larger dropout rate after secondary schooling as compared to Nandkheda.

As per the Census of India 2001, the total number of households and population in Nandkheda village were 256 and 1619, respectively; and House of Asarkheda were 212 and 1245, respectively (Table 1). The population of SC and ST was 21 (8%) and 18 (7%) in

Nandkheda project and 10% in Asarkheda project. Though the Table 2 indicates that the forest land is completely absent in Nandkheda revenue boundary, people have access to this land shown in Marsavali village boundary. The percent of irrigated land to private land was less than 1 in Nandkheda while it was 4 in Asarkheda leading to culturable waste land of 13% and 4%, respectively.

Landless percent in Asarkheda watershed as depicted in Table 3 is three times more than that in Nandkheda watershed. It may be observed from table no. 3 that 50% households own more than 10 acres of land per household covering

Table 2: Distribution of the Geographical Area of Two Villages*

Description	Nandkheda Watershed		Asarkheda Watershed	
	Project Total	Nandkheda	Project Total	Asarkheda
Forest land	240.28		16.78	16.78
Revenue land	114.42	22	64.69	45.87
Panchayat land	2.72	1.22	3.79	3.79
Submerged land	7.25		2.02	2.02
Sub-total **Public Land**	**364.67**	**23.22**	**87.28**	**68.46**
Irrigated land	165.9	5.47	26	26
Un-irrigated cultivated land	1000.69	436.4	652.94	590.62
Culturable waste land	295.79	63.68	44.14	29.7
Un-culturable waste land	34.1	1.79	64.61	64.61
Sub-total **Private Land**	**1496.48**	**507.34**	**787.69**	**710.93**
Grand Total	**1861.15**	**530.56**	**874.97**	**779.39**

*Village Land Records

Table 3: Pattern of Landholding of the Watershed Villages Studied*

Category	Nandkheda		Asarkheda	
Number of Households	**HH nos.**	**% to total**	**HH nos.**	**% to total**
Landless	16	6%	40	19%
0-1 ha	19	7%	14	7%
1-2 ha	23	9%	41	19%
2-4 ha	71	28%	55	26%
4-8 ha	86	34%	49	23%
More than 8 ha	41	16%	13	6%
Total	**256**	100%	**212**	100%
Land Owned/ held in ha#	**Land ha**	**% to total**	**Land ha**	**%to total**
Landless	0	0%	0	0%
0-1 ha	17.48	1%	11.1	2%
1-2 ha	40.62	3%	68.9	10%
2-4 ha	247.08	17%	165	24%
4-8 ha	651.84	45%	283.3	41%
More than 8 ha	493.23	34%	155.4	23%
Total	**1450.25**	100%	**683.7**	100%
Average Landholding per HH	**5.7**		**3.2**	

*Village Land Records. # One Hector = 2.5 Acres.

79% of total private land in Nandkheda. In case of Asarkheda 29% households own more than 10 acres per household covering 64% of total private land. The average landholding of Nandkheda household is almost double the landholding of Asarkheda.

The average landholding per household in Nandkheda and Asarkheda is 5.7 ha and 3.2 ha respectively. These figures indicate combined data of all the villages in the watershed project defined by project boundary. But this figure is quite misleading for the study purpose as it

considers only the selected villages and not whole watershed.

Hence the landholding per household needs to be calculated considering land and household data of selected villages only. In Nandkheda, the average landholding is 2.75 ha taking into consideration total private area of 507.34 ha (Table no. 2) and number of household as 185 (census 2001). Similar calculations show that the average landholding in Asarkheda is 2.74 ha. Thus it is very evident that there is no difference in landholding pattern between two villages.

Both the villages were selected for watershed interventions under IGWDP during the year of 1995. Two NGOs namely Nirman Sanstha and Marathwada Sheti Sahayya Mandal (MSSM) based at Aurangabad initiated awareness and capacity building activities in Nandkheda and Asarkheda respectively during 1995. Watershed Organization Trust (WOTR) Ahmednagar helped them in capacity building phase by way of technical, managerial and funding support. Both the projects entered Full Implementation Phase (FIP) in 1996 wherein NABARD provided funding and monitoring support to the projects. The watershed activities in Nandkheda were completed in February 2001 while Asarkheda watershed project was completed in August 2001.

Table 4 shows that both the projects completed their project measures activities within the sanctioned budget; in fact about 85% of the budget was utilized. Women development activities are provided maximum up to 5% of the total budget. At the time of closure of the project the activities were sanctioned but not yet completed. The activities were completed after the PCR. The maintenance fund figures in Table 4 show programme grant released to the projects. Both the projects received Rs. 90,000 from NABARD as an incentive for successful completion of watershed activities and this fund is also added to the maintenance fund but is not reflected in the table. Project management grant is released to the project implementing agencies as administrative charges for their services. These are delivery costs of the projects and are measured as percent of total project activity grant utilized excluding maintenance fund. The delivery/ administration cost in case of Nandkheda is 21.5% while in case of Asarkheda it is 26.1%.

It comes out from table no. 5 that Nandkheda has utilized most of the treatment funds (97% of total funds spent on treatments- row C in the table) for land treatment as compared to that of Asarkheda (68% of total funds spent on treatments- row C in the table). Land treatment work generates large amount of workdays for labourers as compared to drainage line treatment. In Nandkheda, about 70% of the total treatment cost i.e. Rs. 58.48 lakh* is spent on labour component and paid directly to the labourers from the villages which created employment of about 1,06,151 labour workdays during the entire project period.

In Asarkheda, the labour component is about 61% of total project measures investment. According to the VWC members of Asarkheda, approximately 30% of the labour component i.e. Rs. 6.86 lac is paid to labourers and rest of the amount of Rs. 1.6 million is paid as charges for machinery use in creating land treatments especially farm bunds. Thus only about 18% of the total treatment cost has reached the hands of labourers by way of employment of only about

Table 4: Financial Provisions: Sanctioned and Utilized for Different Components*

Project Component	Nandkheda		Asarkheda	
	Grant sanctioned	Grant utilized	Grant sanctioned	Grant utilized
As on date	**Jan-1996**	**Feb-2001**	**Jun-1996**	**Aug-2001**
Project Measures	9,746,880	8,364,367	4,256,960	3,753,250
Women Development	547,000	41,934	213,000	-
Maintenance Fund	560,000	557,300	266,000	286,392
Project Management	1,952,376	1,808,320	1,167,600	978,992
Total	**12,806,256**	**10,771,921**	**5,903,560**	**5,018,634**

* Watershed Implementation Records.

Table 5: Physical and Financial Details of The Treatment of Watershed Villages*

Sr. No.	Treatment/ Item of Expenditure	Nandkheda		Asarkheda	
		Completed Physical Units (ha/nos)	Grant utilized, Rs.	Completed Physical Units (ha/nos)	Grant utilized, Rs.
A	**Area Treatment, ha**				
1	Afforestation	354.70	2,186,744	35.90	421,949
2	Grassland with Trees	175.55	1,731,011		
3	Agro Forestry	-	-	18.40	86,753
4	Agro Horticulture	149.65	1,010,935	30.82	138,589
5	Crop cultivation	1,007.49	2,840,176	528.13	1,775,456
6	Supervision	-	374,331	-	140,924
	Sub Total (A)	**1687.39**	**8,143,197**	**613.25**	**2,563,671**
B	**Drainage Line Treatment, nos**				
1	Gully plug			316	56,426
2	Loose boulders	11	10,318		
3	Gabion structure, RM			69.77	63,915
4	Check weirs	16	207,702	11	270,315
5	Check dams			4	594,238
6	Earthen Nalla Bunds			5	170,567
7	Repair of Nalla Bunds			2	7,770
8	Supervision		3,150		26,348
	Sub Total (B)	**27**	**221,170**	**408**	**1,189,579**
C	**Treatment Total (A+B)**	**1,687.39**	**8,364,367**	**613.25**	**3,753,250**
	Per ha cost		**4,957**		**6,120**
D 1	**Unskilled Labour Component, Rs.**		**5,847,807**		**2,286,689**
2	Unskilled Labour Payment, Rs.	100% payment	5,847,807	70% machine use	686,007
3	Percent of labour payment to C		70%		18%
E	**Community Shramdan, Rs.**		1,139,795		504,172
	Shramdan percentage to D1		19%		22%
F	**Maintenance Fund**				
1	Collection from families		50,918		155,290
2	Fund with VWC at closure of project		682,253		500,082
G	Labour workdays generated		106,151		15,591

*Watershed Implementation Records.

15,591 labour workdays during the similar project period as that of Nandkheda. Rest 82% of the fund was spent on material and machinery.

Community contribution is required as a pre-condition in IGWDP projects. Both the villages have reached the expected level of Shramdaan as seen in table no. 5, Asarkheda having done 22% of total unskilled labour component. Nandkheda villagers have mostly contributed in terms of manual work i.e. Shramdaan while Asarkheda villagers have provided major component by way of providing cash, kind or machinery. Table 5 also clearly shows that Asarkheda people have collected "family cash collection" of Rs. 1,55,290 towards maintenance

Table 6: Social Structure of the Study Villages*

Respondents Profile	Nandkheda	Percent	Asarkheda	Percent
Total number	22		24	
Average age	51		53	
Caste				
Maratha	20	90.9%	22	91.7%
Christian	1	4.5%		
Navboudhha	1	4.5%		
Nathjogi			1	4.2%
Dhangar			1	4.2%
Illiterate	16	72.7%	9	37.5%
Literate	6	27.3%	15	62.5%
1-4	4	18.2%	3	12.5%
5-10	2	9.1%	11	45.8%
11-12	0	0.0%	1	4.2%

* Census 2001 and Village Records.

Table 7: Level of Skill Acquisition of Surveyed Families.*

Sample HH-Demographic		Nandkheda	Percent	Asarkheda	Percent
Population	Total	96		120	
	Male	53	55.2%	65	54.2%
	Female	43	44.8%	55	45.8%
Education	None	42	44%	47	39.2%
	Literate	54	56%	73	60.8%
	0-4	10	19%	15	21%
	5-10	40	74%	49	67%
	11-12	3	6%	7	10%
	>12	1	2%	2	3%
Skills	Weaving	1		4	
	Driving	1		3	
	Electrical			1	
	Other	2			
Training- Crop & WS		1		3	
Training- Livestock		0		3	

*From The Field Survey.

fund, which is triple, the collection of families of Nandkheda. Through addition of programme contribution into the maintenance fund, Nandkheda and Asarkheda have accumulated an amount of Rs. 6,82,253 and Rs. 5,00,082 respectively at the end of the project. Table 5 reveals the fact that watershed has generated more than 106,000 person-days of unskilled employment in Nandkheda which is 7 times of that Asarkheda.

3.2. Comparative impacts of watershed interventions

Seven years have passed since the completion of both the projects. The communities have experienced the impacts and outcomes of the watershed for a fairly long time. The study focused on collection of primary data on various impacts of watershed interventions that are seen, perceived and sustained by the community. Efforts were made to ensure that the respondents are head of the family.

Respondents for twenty-two households of Nandkheda and twenty-four households of Asarkheda villages were interviewed for the present study. The respondent's age profile indicates that they were quite in-charge of their family during watershed project period i.e. ten years back.

The respondents' level of illiteracy is high in Nandkheda and the literacy level is significantly lower compared to Asarkheda. In Asarkheda, the literacy level is slightly better, specifically with reference to respondents who are educated in the range between 5-10 standards. In both cases, as brought out by Table 6, about 91% respondents are from Maratha community with some representative respondents from other minority community in the villages.

In both the villages, amongst the number of sample households, male population is approximately 10% more than that of females.

Education level of the people is enhanced especially the number of High School going children is significantly increased as compared to the pre-watershed situation. There is not much improvement in college level education though the general literacy level shows improving trend. A few people have acquired vocational skills of livelihood such as weaving, electrician ship, driving etc. There are 6 persons in Asarkheda who are trained in watershed development and livestock management during the project period from the PIA itself.

Occupational Pattern at the current situation, in both the villages shows that they draw employment from growing crops in all seasons except Nandkheda drawing more from Agricultural labour in summer. If compared, the total number of persons engaged in other livelihood activities in all three seasons after watershed implementation, the situation is significantly better in Asarkheda as compared to Nandkheda. In Nandkheda the number of persons engaged in livelihood activities has remained the same, whereas in Asarkheda they have increased.

With respect to migratory labourers, there is no change in the situation in Nandkheda as the same number of persons continues to migrate in all the three seasons. In Asarkheda there is no incidence of migratory labourers observed in both periods. Significant number of persons in Nandkheda is engaged as agriculture labour during summer in both periods, whereas in Asarkheda negligible number persons is

Table 8: Pre and Post Watershed Occupational and Crop Diversification of the Study Villages*

Occupation	Nandkheda			Asarkheda		
Kharif	**Pre-WS**	**Post-WS**	**% change**	**Pre-WS**	**Post-WS**	**% change**
Crop	44	52	18%	42	47	12%
Livestock	1	2	100%	1	0	100%
Agri. Labour	5	0	100%	3	1	67%
Migration	5	5	0%	0	0	Nil
Other	42	33	21%	10	14	40%
Rabbi						
Crop	45	52	16%	39	47	21%
Livestock	2	2	0%	1	0	100%
Agri. Labour	1	2	100%	1	1	0%
Migration	4	4	0%	0	0	NA
Other	42	33	21%	5	14	180%
Summer						
Crop	0	0	NA	26	30	15%
Livestock	0	6	Infinite	1	0	100%
Agri. Labour	47	53	13%	0	1	Infinite
Migration	4	4	0%	0	0	Nil
Other	43	30	30%	5	13	160%

* From The Field Survay.

Table 9: Pre and Post Watershed Comparison of Family Assets of the Villagers*

Family Assets	Nandkheda			Asarkheda		
	Pre-WS	Post-WS	% Change	Pre-WS	Post-WS	% Change
House	20	22	10%	21	24	14%
Electricity	1	1	0%	10	11	10%
Own land	20	20	0%	21	23	10%
Lease land	1	1	0%	1	1	0%
Large Animals	18	19	6%	16	15	6%
Small Animals	9	11	22%	6	9	50%
Open well	15	16	7%	18	22	22%
Tank Irrigation	5	6	20%	0	0	NA
Water lifting devices	12	15	25%	9	19	111%
Tractor	0	0	Nil	1	1	0%
Bicycle	2	6	200%	4	8	100%
Motorbike	0	0	Nil	1	10	900%
Television	0	1	Infinite	2	14	600%

* From The Field Survey.

Table 10: Source of Funds for Building Family Assets of Two Villages*

Source of Funds	Nandkheda		Asarkheda	
Parental	41	61%	51	41%
Farm Income	20	30%	70	56%
Agri. Labour	4	6%	3	2%
Watershed labour	2	3%	1	1%
Total	67	100%	125	100%

* From The Field Survey.

Table 11: Sources of Irrigation and Average Water tables of Villages*

Wells and lifting devices	Nandkheda	Asarkheda
Wells	16	22
Electric Motors	16	22
Diesel Engines	4	9
Depth of water (feet)	9.5	6.2

* From The Field Survey.

involved in this activity throughout the year. This is probably because of land preparation activities done in summer so as to get ready for kharif crops. These works are done by manual labour and draft animals in Nandkheda while the farmers in Asarkheda mostly prefer tractor driven agriculture implements to do similar works.

Table 8 shows that there is an increase in the range of 12% to 21% in number of persons engaged in crop production activities in kharif and rabbi season respectively in Asarkheda. In the case of Nandkheda, it shows 18% increase in employment in crop production in kharif while 16% increase in employment during rabbi production. In both the villages, the livestock has not much developed much as livelihood alternative for people, possibly due to poor

accessibility to tarred road and credit from banks. Overall, there is no change in Nandkheda, in fact nominal negative change is discernible in the number of people employed in pre-watershed and current situation. The employment opportunities have been significantly increased within Asarkheda village by about 35%. Most of this increment is due to a rise in area (Table 18) and income (Table 23) under cash crops with higher labour requirement.

As far as family assets in post-watershed are concerned, it is depicted in Table 9. The increase in assets of Asarkheda is observed to be significantly higher as compared to Nandkheda. During the last 10 years, the people of Asarkheda have increased capital building assets such as irrigation facilities through well digging and water lifting schemes and communication facilities such as motorbike and television. Opposed to that, the people of Nandkheda could invest comparatively lesser capital or communication building assets and used the income mostly for the purpose of consumption and debt repayment.

As indicated in Table 10, in Asarkheda the main source of money for assets mentioned above is farm income. In Nandkheda, people mostly attribute the assets towards the parental income and it is evident from the table no. 10 that watershed labour has not helped much to build or increase the assets for the villagers. Table 11 shows the status of irrigation facilities such as wells and lifting devices in the study villages. The average depth of water in the open wells is better in Asarkheda than in Nandkheda.

Table 12 brings out that the average area owned per sample family is more than double in Asarkheda (12.7 acres) as compared to Nandkheda (5.7 acres). This is contrasts with the pre-watershed data mentioned in Table 3 because it reveals the situation of all 4 villages covered in the watershed project. Table 12 tells the figures of only the villages under study.

Table 12 also suggests that the percent of area irrigated to the total private land is similar in both the villages and increased by more than 25% as compared to the pre-watershed period. Out of this irrigated land, about 95% area is irrigated by groundwater in Asarkheda, which is 10% greater than in Nandkheda. Nandkheda has an additional option of tank water irrigation for 16% of irrigated land; almost 3 times more than Asarkheda.

As far as the land characteristics in the study villages are concerned, it is indicated in table no. 13 that most of the private land is moderately sloping (62%) in Nandkheda while it is evenly distributed among different slopes in Asarkheda having higher proportion of steep slope land (26%). Comparatively more lands in Asarkheda (37%) are flatter than Nandkheda (30%). Soils in both the villages are mostly black and red color having similar characteristics.

As is revealed in Table 14 that about 5% land is not treated at all in the project in Asarkheda, while all the farms are treated in Nandkheda. The reason for non-treatment is not clear. All these soil conservation treatments are carried out through watershed funding. The private lands in both watersheds are mostly treated with farm bunds and gully plugs wherever gully passes through the farm. It is clear from Table 15 that a little less than three times the number of households in Asarkheda than Nandkheda invested in water lifting facilities such as electric motor, pipeline, etc. for irrigation purpose. Table 9 brings out the similar fact that Asarkheda families have raised their water lifting assets by 111%. This helped them to bring more cropland under irrigation. Table 15 indicates that Nandkheda households prefer investing in wells

Table 12: Land Distribution As Per The Source of Irrigation of The Study Villages*

Land distribution, acre	Nandkheda		Asarkheda	
	Area	Per HH/ Percent	Area	Per HH/ Percent
Area owned, acre	119.5	5.7	291.5	12.7
Area Irrigated	37.5	31%	93.9	32%
Groundwater Irrigated	31.5	84%	88.9	95%
Tank water irrigated	6.0	16%	5.0	5%

* From The Field Survey.

Table 13: Land Characteristics and Soil Type in the Study Villages*

Land Characteristics	Nandkheda		Asarkheda	
Topography	**Acres**	**Percent**	**Acres**	**Percent**
Steep slope	11.0	9%	76.4	26%
Moderate slope	73.5	62%	106.6	37%
Slight slope	8.0	7%	42.0	14%
Flat	27.0	23%	66.5	23%
Total	119.5	100%	291.5	100%
Soil Type (acre)	**Acres**	**Percent**	**Acres**	**Percent**
Red	54.5	46%	139.1	48%
Black	60.0	50%	112.4	39%
Other	5.0	4%	40.0	14%
Total	119.5	100%	291.5	100%

* Watershed Implementation Records.

Table 14: Village and Category wise Investment on Soil and Water Conservation and Sources of funds in the Study Villages*

Item of Investment	Nandkheda		Asarkheda	
	Acres	**Percent**	**Acres**	**Percent**
Nil	0.0	0%	13.9	5%
Bunds	109.5	92%	255.6	88%
Gully plugs	10.0	8%	0.0	0%
Bund and Gully plugs	0.0	0%	22.0	8%
Total	119.5	100%	291.5	100%
Source of Funds	**Acres**	**Percent**	**Acres**	**Percent**
None	0.0	0%	14.4	5%
Watershed fund	119.5	100%	277.1	95%
Total	119.5	100%	291.5	100%

* Watershed Implementation Records.

Table 15: Category wise Investment on Irrigation and Sources of Funds in The study Villages*

Irrigation Investment	Nandkheda		Asarkheda	
	Household	**Percent**	**Household**	**Percent**
None	2	9%	2	8%
Lift irrigation	3	14%	9	38%
Tube well	2	9%	3	13%
Well	14	64%	9	38%
Other	1	5%	1	4%
Total	22	100%	24	100%
Source of Funds for Irrigation facilities				
Watershed earnings	10	50%	2	9%
Own	7	35%	15	68%
Loan	3	15%	5	23%
Total	20	100%	22	100%

* From The Field Survey.

Table 16: Comparison of Pre and Post Watershed Livestock Composition and Income*

Livestock		Nandkheda			Asarkheda		
		Before	Present	% change	Before	Present	% change
Indigenous Bullocks	Number	36	39	8%	23	24	4%
	Income/yr				51,500	142,000	176%
Dairy Cattle	Number	28	29	4%	21	17	19%
	Income/yr				22,000	53,000	141%
Buffaloes	Number				6	7	17%
	Income/yr				25,000		100%
Goats	Number	43	43	0%	7	14	100%
	Income/yr		27,000		4,062	30, 000	639%

* From The Field Survey.

Table 17: Pre and Post Watershed Pattern of Livestock owning households*

LS owned Households	Nandkheda			Asarkheda		
	Before	Present	% change	Before	Present	% change
Bullocks	18	18	0%	12	11	-8%
Cattle	13	13	0%	11	9	-18%
Buffaloes				4	4	0%
Goats	12	13	8%	5	6	20%

* From The Field Survey.

for irrigation purposes. But table no. 9 shows very small increase in the number of wells during the last several years. That means the farmers have to put in their funds to repair and for the maintenance of already existing wells.

For the irrigation investment, 50% households of Nandkheda utilized their earnings from watershed labour (Table 21 indicates 7% of labour earnings going to irrigation) whereas in Asarkheda 68% used their own sources. Proportion of households opting for loan for this purpose is also greater in Asarkheda.

As shown in Table 16, a slight increase in bullock (8%) and indigenous dairy cattle (4%) is observed as far as Nandkheda is concerned. However the number of households owning livestock as per Table 17, has remained the same, except for households owning goats which have increased by 8%. Here the goats constitute the only animal source that provides income in post-watershed era. The number of households owning livestock in Asarkheda has declined, with the exception of households that own goats (increase noted). A decrease is noted in number of indigenous dairy cattle as per Table 16, whereas increase is observed in the number of goats.

However, Table 16 also shows that the livestock is an important source of income in case of Asarkheda and a significant increase in earnings is noted through bullocks, indigenous cattle and goats. An increase in fodder and water availability or modern livestock management practices could have contributed to this. However, buffaloes are the only exception that does not seem to provide any income in post-watershed period.

Table 18 brings out crop diversification as a result of the watershed projects in two the villages. The area under cotton crop has increased by 21% in Nandkheda. Productivity per acre in both the villages has increased by about 75% as compared to the pre-watershed period. The cotton price has gone up significantly as it falls under government monopoly procurement scheme. The area under wheat (a rabbi crop) has decreased by 67% in Asarkheda. Productivity per acre has increased by more than 60% in the post-watershed period.

The area under maize cultivation has almost doubled in Asarkheda resulting in the doubling of productivity per acre and about 70% rise in maize price. Nandkheda shows a minimum area under maize with very little change in the value

Table 18: Post Watershed Changes in cropping Pattern and Production of Study Villages#

Crop Pattern	Nandkheda			Asarkheda		
Cotton	**Before WS**	**Present**	**% change**	**Before WS**	**Present**	**% change**
Area,acre	56	68	21%	110	109	-1%
Prod/acre	9.21	15.95	73%	4.76	8.32	75%
Value	2000	2500	25%	1525	2239	47%
Bajra	**Before WS**	**Present**	**% change**			
Area,acre	38.00	30.50	-20%			
Prod/acre	7.52	11.29	50%			
Value	300	590	97%			
Wheat	**Before WS**	**Present**	**% change**	**Before WS**	**Present**	**% change**
Area,acre	25	22	-12%	3	1	-67%
Prod/acre	7.20	11.69	62%	5.50	10.00	82%
Value	700	1100	57%	550	1100	100%
Maize	**Before WS**	**Present**	**% change**	**Before WS**	**Present**	**% change**
Area,acre	1	1	0%	7	13	86%
Prod/acre	11	15	36%	10.60	22.30	110%
Value	600	700	17%	300	592	97%
Jawar				**Before WS**	**Present**	**% change**
Area,acre				41.20	35.00	-15%
Prod/acre				6.72	10.43	55%
Value				497	1,453	192%

* Column 'Present' depicts the data at the time of the study; # From The Field Survey.

Table 19: Availability of labour work in watershed*

Households	Nandkheda		Asarkheda	
Yes	22	100%	9	38%
No	0	0%	14	58%
No response			1	4%
Total	22	100%	24	100%
Population	**Number**	**Per HH**	**Number**	**Per HH**
No. of labourers	47	2.14	25	2.78
Workdays	11,150	507	2,235	248
Earnings, Rs.	674,000	30,636	100,400	11,156

* From the Field Survey.

of production even after a 36% rise in productivity. In case of Bajra, the area in Nandkheda has decreased slightly even though the production per acre shot up by 1.5 times and the price almost doubled during these years. Similarly area under Jowar has decreased in Asarkheda even after a 1.5 times rise in productivity and almost tripling of the price.

Table 18 overall indicates declining trend of food crops production like Wheat, Bajra and Jowar. This trend is in tandem with the general trend and possibly leading to the rise in prices of these crops. These staple food crops are being replaced by crops such as cotton and maize as well as vegetables and horticultural crops that provide cash income to the farmers. It may also be noted (from table 18) that the increase in productivity of food crops except wheat, is lesser than the increase in productivity of Cotton and Maize crops. That surely points towards farmer's inclination of more inputs/investment in cash crops.

Table 20: Promoter of Labour Work*

Labour Promoter	Nandkheda		Asarkheda	
Self (labourer)	9	41%	0	0%
Supervisor	13	59%	3	13%
Engineer	0	0%	6	25%
No response			15	63%
Total	22	100%	24	100%

* From The Field Survey.

Table 21: Expenditure Pattern of Labour Earnings*

Expenditure Pattern	Nandkheda	
	Amount Rs	Percent
Earnings, Rs.	**674,000**	100%
House	45,000	7%
Irrigation Facility	45,000	7%
Livestock	5,000	1%
Debt Recovery / Repayment	315,000	47%
Health	76,000	11%
Education	39,500	6%
Food/clothes	48,500	7%
Marriage/ festival	40,000	6%
Savings	60,000	9%

* From The Field Survey.

Table 22: Use of Machine in Own Farm*

Machine use in own farms	Nandkheda	Asarkheda
Yes	18	19
No response	4	5
Bunding work		1
Ploughing		14
Threshing	18	4

* From The Field Survey.

As depicted in Table 19, in Nandkheda 100% sample households (22) offered to work as labourers during the project period, whereas in Asarkheda, only 38% people said they were employed. Nandkheda project generated about 507 person days of labour work for each household while Asarkheda project generated 248 person days of labour work for each household during the entire project implementation period. The earning through labour per household is also substantially higher in Nandkheda (Rs. 30,636) than in Asarkheda (Rs. 11,156). This might be due to the use of machinery such as tractor and bulldozer to undertake watershed works in Asarkheda village in place of labourers.

As far as the motivation of villagers to work on the watershed project is concerned, it is clear that in Nandkheda, 41% households were self-motivated and watershed supervisor (trained local youth) mobilized 59% households to work as watershed labourers. Such self-motivation is completely absent in Asarkdea with 63% households not responding to the question (Table 20). It is clear that the people did not prefer that type of work in watershed even

Table 23: Pre and Post Watershed Average Income per Household- season-wise amount*

Average income per household-Amount Rs. Nandkheda		Nandkheda			Asarkheda		
		Pre-WS	Present	% change	Pre-WS	Present	% change
Food crops	Kharif	2,243	6,805	203%	6,206	16,022	158%
	Rabbi	4,993	11,344	127%	4,389	9,316	112%
Cash crops	Kharif	20,000	38,750	94%	16,778	45,933	174%
	Rabbi				8,571	32,900	284%
Wage labour in the village	Kharif	1,500	2,250	50%	2,333	13,000	457%
	Rabbi	-	1,000		2,667	15,500	481%
	Summer				2,500	16,000	540%

*From The Field Survey.

Table 24: Average Income per Household- Number of Household*

Average income per household- HH nos.	Nandkheda			Asarkheda		
Food crops- Kharif	**Before**	**Present**	**% change**	**Before**	**Present**	**% change**
Less than Rs. 2000	14	0	-100%	5.0	1.0	-80%
Between Rs. 2000-5000	6	12	100%	6.0	5.0	-17%
Between Rs. 5000-10000	1	5	400%	4.0	5.0	25%
Greater than Rs. 10000		4	infinite	2.0	7.0	250%
Food crops- Rabi						
Less than Rs. 2000				9.0	1.0	-89%
Between Rs. 2000-5000	6		-100%	6.0	6.0	0%
Between Rs. 5000-10000	6	6	0%	1.0	5.0	400%
Greater than Rs. 10000		10	infinite	2.0	7.0	250%
Cash crops- Kharif						
Less than Rs. 10000	1		-100%	8.0	3.0	-63%
Between Rs. 10000-25000	16	1	-94%	6.0	3.0	-50%
Between Rs. 25000-50000	2	16	700%	4.0	8.0	100%
Greater than Rs. 50000		1	infinite		7.0	infinite
Cash crops-Rabi						
Less than Rs. 10000				5.0	2.0	-60%
Between Rs. 10000-25000				2.0	5.0	150%
Between Rs. 25000-50000				-	1.0	infinite
Greater than Rs. 50000				-	2.0	infinite

* From The Field Survey.

though they had an opportunity to work as labourers. Whoever has worked as a labourer has been mobilized mostly by the engineer and then the watershed supervisor in Asarkheda.

In the case of expenditure of earnings from labour work in watershed projects, the earnings of labourers in Asarkheda is minimal, hence there is no response to this question. Table 21 reveals that the households in Nandkheda spent a major portion (47%) of their labour earnings on repayment of debt to moneylenders and other non-institutional sources, mainly the traders and

Table 25: Debt Pattern of Pre and Post Watershed of The Villages*

Loan pattern	Nandkheda			Asarkheda		
	Before	Present	% change	Before	Present	% change
Number of HH	5	3	-40%	6	9	50%
Bank	1	1	0%	3	5	67%
Moneylender	4	2	-50%	3	4	33%
Agriculture purpose	2	1	-50%	5	8	60%
Marriage/Festivals	1	2	100%	1	1	0%
Housing purpose	2		-100%			

* From The Field Survey.

Table 26: Village wise Participation in Watershed Programme*

Household Participation in Watershed Programme	Nandkheda		Asarkheda	
No participation	0	0%	14	58%
Participated as VWC member	8	36%	4	17%
Participated in meetings	0	0%	1	4%
Participated through other means	14	64%	0	0%
Passively participated	0	0%	2	8%
No response			3	13%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 27: Involvement in Other Village Organization*

Involvement in other village organisation	Nandkheda		Asarkheda	
None	0		18	75%
SHG member	22	100%	3	13%
Gram Panchayat member	0		1	4%
No response			2	8%
Total respondants	22		24	100%

* From The Field Survey.

Table 28: Participation in Soil and Water Conservation Measures*

Household participation in SWC	Nandkheda		Asarkheda	
No participation	0	0%	2	8%
Voluntary Labour (Shramdan)	20	91%	3	13%
Private investment on own land	0	0%	6	25%
Contribution to overall cost (cash or kind)	0	0%	11	46%
Plantation on own land	1	5%	1	4%
Other	1	5%	1	4%
Total respondants	22	100%	24	100%

* From The Field Survey.

relatives. Rest of the expenditure is spread over health, house construction, consumption items like food and clothes, education of children and celebration of festivals and marriages. Only 7% of the income is invested on increasing irrigation facilities followed by notional investment on livestock development. Few households did save about 9% of their labour income.

Table 29: Value of Local Contribution*

Value of Local contribution (Rs.)	Nandkheda		Asarkheda	
Nil	0	0%	2	8%
Less than Rs. 1000	0	0%	12	50%
Between Rs. 1000 to Rs. 5000	14	64%	8	33%
Between Rs. 5000 to Rs. 10000	6	27%	1	4%
More than Rs. 10000	2	9%	0	0%
No response			1	4%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 30: Plan of Continuation of Soil and Water Conservation*

Plan for SWC continuation	Nandkheda		Asarkheda	
Not planned	8	36%	11	46%
Do not know		0%	1	4%
Use less water	2	9%	4	17%
More stall feeding of livestock	0	0%	3	13%
Maintenance of works on own land	10	45%	1	4%
Contribute to maintenance of common land	1	5%	0	0%
Combination of above	1	5%		0%
Other		0%	1	4%
No response			3	13%
Total respondants	22	100%	24	100%

* From The Field Survey.

As far as the use of machine in own farms is concerned, in Asarkheda, 19 out of 24 respondents (Table 22) said that they were consulted for, and agreed to, the decision of using machinery for watershed works. About thirteen households are satisfied with the quality of works implemented by using machinery. About 80% households in both the villages use machinery for farm operations on their farms. Asarkheda farmers use mostly tractor for ploughing of land while Nandkheda farmers use threshers for threshing the crop harvest.

In Asarkheda, there have been substantial increases in the average income of households with respect to cultivation of food crop as well as cash crops during the two seasons (Table 23). The same trend is observed with wage labour in watershed. In Nandkheda, the rise in income from food crops in both kharif and rabbi seasons are significantly higher than in Asarkheda. But the increase in income from cash crop is lower than in Asarkheda and is restricted only to kharif season. Although the increase in income from wage labour in Nandkheda village is noted, it is not as impressive as in Asarkheda. This might be attributed to the increased production of cash crops in Asarkheda leading to more availability of wage labour within the village. It is observed that labourers from Nandkheda are currently working in stone quarries in and nearby villages.

In both the villages the positive trend is observed as seen in table no. 24 with respects to shift in the number of households that earn more income (from food and cash crops) as well as increase in range of earning (for e.g. from range of Rs. 2000-5000 to the range of more than Rs. 10,000). This trend is observed to be better in Asarkheda as compared to Nandkheda.

As far as debt pattern in Nandkheda in post-watershed period is concerned, there has been decline in the number of persons that have taken loans, where as Asarkheda an increase is noted in the number of persons taking a loan and as larger number of persons approach banks for loans

Table 31: Extent of Interest of Villagers in Watershed Management*

Extent of interest in Watershed Management	Nandkheda		Asarkheda	
Not interested at all	2	9%	1	4%
Not very interested	0	0%	2	9%
Somewhat interested	15	68%	3	13%
Fairly interested	1	5%	0	0%
Very interested	4	18%	16	70%
No response			1	4%
Total respondants	22	100%	23	100%

* From The Field Survey.

Table 32: Level of Awareness of Villagers about Land Degradation of Common Land*

Extent of interest in Watershed Management	Nandkheda		Asarkheda	
Very degraded	1	5%	4	17%
Fairly degraded	4	18%	0	0%
Somewhat degraded	11	50%	10	42%
Not very degraded	1	5%	4	17%
Not degraded at all	5	23%	4	17%
No response			2	8%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 33: Reasons for Common Land Degradation*

Reasons for degradation of common land	Nandkheda		Asarkheda	
Overgrazing	5	23%		0%
Deforestation	11	50%	7	29%
Destruction by some people	4	18%	12	50%
Conflicts in the community	1	5%		0%
Lack of rules and regulations	1	5%	1	4%
No response			4	17%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 34: Suggested Means of Reducing Degradation*

Options to reduce degradation of common land	Nandkheda		Asarkheda	
Do not know	1	5%		0%
Reduce number of livestock	5	23%	2	8%
New rules and regulations	3	14%	10	42%
Fencing	1	5%	2	8%
Higher penalties for breaking rules		0%	6	25%
More watchmen	11	50%		0%
Other	1	5%		0%
No response			4	17%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 35: Level of Awareness of Villagers about Water Resource Depletion*

Extent of water resource depletion	Nandkheda		Asarkheda	
Almost depleted	4	18%	2	8%
Considerable depletion	4	18%	9	38%
Seasonal depletion	13	59%	6	25%
Irregular scarcity problem	1	5%	3	13%
No problem with water availability	0	0%	1	4%
No response			3	13%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 36: Reasons for Water Resource Depletion*

Reasons for water resource depletion	Nandkheda		Asarkheda	
Too many bore wells	5	23%	3	13%
Natural reasons like bad monsoon	13	59%	16	67%
Overpopulation	1	5%	1	0%
Over use by some people	3	14%	1	4%
Negligence by the government		0%	1	4%
Conflicts in the community		0%	1	4%
Lack of water storage and conservation		0%	1	4%
No response				4%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 37: Suggested Means of Reducing Water Depletion*

Options to reduce the water resource depletion	Nandkheda		Asarkheda	
Do not know	1	5%	2	8%
Increased water storage and conservation	11	50%	4	17%
Ruels and regulations	2	9%	1	4%
Ban on borewells	4	18%		0%
Ban on certain crops	1	5%	9	38%
Reforestation	3	14%	5	21%
No response			3	13%
Total respondants	22	100%	24	100%

* From The Field Survey.

particularly for agricultural purpose (Table 25). The following tables indicate the opinion and perceptions of the respondents with regard to participation, leadership, village institutions and resource status in their respective villages. These perceptions are important and indicate the level of awareness and participation of respondents with respect to different concepts and issues in natural resource management.

With respect to the level of participation (table no. 26), it is far better in Nandkheda than in Asarkheda. Nandkheda people have mostly participated by way of actual labour force and in VWC meetings. In Asarkheda almost 66% have not participated (no or passive participation).

With regard to the involvement in village organizations other than watershed committee, the situation is better in Nandkheda as 100%

Table 38: Perception about Benefits of Watershed Development by Households*

Household benefits of watershed development	Primary Benefits				Weighted ranking- all together			
	Nandkheda		Asarkheda		Nandkheda		Asarkheda	
No benefit	0	0%	3	13%	0	0%	15	10%
Employment	8	36%	10	42%	26	20%	30	21%
More water in wells/borewells	4	18%	3	13%	26	20%	9	6%
More soil moisture	1	5%		0%	4	3%	0	0%
Better availability of drinking water	1	5%	1	4%	3	2%	3	2%
Crop production increment	2	9%		0%	12	9%	9	6%
Water availability	5	23%		0%	37	28%	18	13%
Land improved	1	5%		0%	17	13%	0	0%
No response		0%	7	29%	6	5%	60	42%
Total respondants	22	100%	24	100%	131	100%	144	100%

* From the Field Survey.

Table 39: Distribution of Watershed Benefits*

Distribution of watershed benefits: Main beneficiaries	Nandkheda		Asarkheda	
Everybody gained equally	5	23%	2	8%
Landowners near nalla	12	55%	8	33%
Landowners downstream	2	9%	9	38%
Landowners with wells/ borewells	3	14%	3	13%
No response			2	8%
Total respondants	22	100%	24	100%

* From the Field Survey.

sample households have participated in SHGs and in Asarkheda, 75% are not involved in any of the village level organizations (Table 27).

About 91% of the households in Nandkheda, participated in soil and water conservation activities by way of Shramdaan through actual labour work (Table 28), while only 5% of the households undertook plantation on their farms. Contribution to overall cost by households in terms of cash or kind is highest at 46% in Asarkheda followed by private investment on own land whereas voluntary labour is only 13%. Nandkheda saw about 36% of the households contributing more than Rs. 5000, while 64% of the households contributed between Rs. 1,000 and Rs. 5,000. This came mostly by way of actual voluntary labour i.e. Shramdaan (Table 29).

The value of local contribution in Asarkheda in case of 58% of the households is very nominal i.e. less than Rs. 1000 and even nil. Only 4% of the households have made contributions worth between Rs. 5,000 and Rs. 10,000. This pattern leads to far lesser local contribution than required. Contrary to this, Asarkheda project has achieved (22%) and in fact exceeded the required amount (19%) of local contribution (Table 5) during the project period. This brings out the possibility that machinery owners', being the ones who are the sources of required value of local contribution, though this has not been verified.

As per Table 30, Nandkheda people insist mostly on maintenance of SWC works on their own land (45%) followed by use of less water (9%) and contribution to maintenance of common land (10%). In contrast to this, Asarkheda community is mostly (59%) found to be unaware about the need of maintenance though 17% and 13% of the households talk about use of less water and stall-feeding of livestock instead of free grazing respectively. About 8% of the households think of maintenance of private land treatments.

Asarkheda people indicate much higher interest (70%) in the watershed management and

Table 40: Attendance in the Village Meetings*

Do not attend meetings	Nandkheda		Asarkheda	
Do not attend meetings	4	18%	6	25%
Gram Panchayat meetings	18	82%	2	8%
Water user association meetings	0	0%	3	13%
Watershed committee meetings	0	0%	12	50%
No response			1	4%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 41: Capability to Influence the Decisions in the Meetings*

Capability to influence the decisions in the meetings	Nandkheda		Asarkheda	
Not at all	15	68%	8	33%
Sometimes, depends on issue	1	5%	10	42%
Can influence considerably	6	27%	4	17%
No response			2	8%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 42: Perceptions of Villagers about Functioning of Village Representatives*

Functioning of village representatives in interest of people	Nandkheda		Asarkheda	
Do not know		0%	1	4%
To a certain extent	2	9%	1	4%
In most cases	8	36%	14	58%
Improving the welfare of all	12	55%	7	29%
No response			1	4%
Total respondants	22	100%	24	100%

* From The Field Survey.

Table 43: Working with Employment Guarantee Scheme*

Worked under Employment Guaranttee Scheme in last year	Nandkheda		Asarkheda	
No	15	68%	20	83%
Less than 2 weeks	0	0%	1	4%
More than 2 weeks	7	32%	2	8%
No response			1	4%
Total respondants	22	100%	24	100%

* From The Field Survey.

at the same time showed no interest (17%). There exists bigger number of households showing extreme opinions in Asarkheda as against Nandkheda, wherein people show mid-position (73%) with regard to the interest. Following three tables (Table 32, 33 and 34) bring out the opinions of households with regard to the extent and reasons of degradation of common land in the villages and also the possible options to overcome the degradation. Nandkheda people accept some degradation with a large majority and believe deforestation to be the prime reason

for this, followed by overgrazing. They suggest appointing more watchmen and reducing the number of livestock to control further degradation than the self-control over it.

People in Asarkheda think of similar type of degradation but hold destruction by some people followed by deforestation as responsible for this state or affairs. They want to create new rules and regulations and mechanism to enforce them in order to reduce degradation. In this case the voluntary model of ban on various activities such as felling of trees and free grazing of cattle will be more useful than the introduction of new rules and appointing watchmen.

Following three Tables 35, 36 and 37 express the opinions of households with regard to the extent and reasons for depletion of water resources in the villages and also the possible options to stop further depletion of these resources. Nandkheda community opines that water resource depletion is mostly a seasonal phenomenon and happens due to natural reasons. Some people accept that depletion exists due to increased number of wells and tube-wells leading to overuse of water by some people. According to them, increasing the storage of rainwater and a ban on tube-wells/ wells would reduce the rate of depletion. Further the water use efficiency by way of shifting towards micro irrigation practices could be a proper solution on preventing the depletion of water resources in the vicinity.

Asarkheda community has rather mixed opinions about the water depletion with 46% accepting absolute depletion, 25% putting this as seasonal and 13% indicating irregular scarcity instead of depletion. They also link this water depletion with bad monsoons and to too many water extraction points ban on certain high water consuming crops and reforestation are main mechanisms thought out by them to control depletion followed by increased rainwater harvesting.

Table 38 and 39 indicate the benefits of watershed development projects and their distribution as perceived/ understood by the households. Both the villages perceive employment and water availability (including groundwater) as primary benefits of the project. The weighted average of data on primary, secondary and tertiary benefits as perceived by households confirm these benefits for Asarkheda but brings out water availability as the main benefit for Nandkheda villagers. Asarkheda people negating employment as prime benefit is surprising particularly in the light of the project records showing lesser employment generation for labourers. This probably is because of 29% of the households did not respond to the question at all. About 10% of the households mention that they have not felt that they have derived any benefit from the project.

With respect to the distribution of benefits, both the villagers mention that watershed benefits accrued largely to the downstream landowners with access to 'nalla'. About 23% of the households in Nandkheda feel that it benefited everybody equally. About 14% of the households in both the villages attribute the benefits to the well owning farmers.

The next tables indicate the outcome of the capacity building strategies followed during the project implementation and management. Nandkheda people usually attend most of the meetings called by the Gram Panchayat such as Gramsabha but only about 32% believed they could influence the discussions at these meetings. In Asarkheda, the watershed committee seems to be more active and 50% of the households participate in the meetings called by VWC (Table 40). Majority of the households feel that they can influence the issue-based discussions. About 18% from Nandkheda and 25% from Asarkheda do not attend any of the village meetings (Table 40).

In both villages, people believe that their leaders generally work in the interest and welfare of all the villagers (Table 42). About 32% of the households worked under EGS works for more than 2 weeks in Nandkheda as against the 12% of the households of Asarkheda during the last year (Table 43).

4. Policy implications

Applicability of policy framework provided for use of machine in watershed development programmes depends mainly on the condition of local community at the time of inception of the project. The pre-project situation of the village in consideration needs to be established by understanding; 1) socio-physical situation from

diverse perspectives such as socio-economic, political, cropping pattern, income and debt patterns, migration and infrastructure, communication and available extension facilities and 2) level of awareness and knowledge in the community about sustainable management of natural and human resources and long term goals of their own development. Also the situation analysis needs to be extended beyond the project villages to the whole cluster in the vicinity so that needy and poor are benefited from the watershed project.

Therefore, merely considering the availability of labourers as a basis for choice of machine-use in watershed would be disastrous. When the local community and the agencies involved in the project are crystal clear about this situational understanding then their decisions on implementing the watershed project through labour or machine will lead to cost effectiveness, appropriate employment opportunities, sustenance of the post-project benefits and more equitable distribution of the same.

5. Final remarks

Baseline situation of a village in pre-project period is determinant of the outcomes of the watershed interventions. Nandkheda initiated the watershed project in a situation of heavy debts largely from informal credit sources and people heavily dependent on the occupations other than agriculture. In the pre-watershed situation, agriculture in Nandkheda provided occupation for hardly 45% of the people even in kharif and rabbi seasons and nil in summer as against this more than 80% of the people in Asarkheda throughout the year. Nandkheda had cultivable wasteland up to 13% and irrigation potential of hardly 1% during 1995-96, while Asarkheda showed 4% cultivable waste land and 4% irrigation at that time. Water harvesting potential of Nandkheda seems to be lower than that of Asarkheda resulting in no check dam and earthen nalla bunds in Nandkheda as against 11 in Asarkheda. They were also involved in cottonseed plots that provide high-income opportunities to the farmers. This baseline situation of Asarkheda suggests that they were well equipped to undertake progressive farming even at the time of the beginning of the watershed project. Even today, Asarkheda village is in a better position than Nandkheda in terms of proximity and access to facilities like health, higher education, credit institutions, agriculture extension and political establishments. The forgoing analysis suggests that the pre-project situation influences the process of project implementation as well as the extent of impacts achieved.

The watershed intervention in Nandkheda generated about 1,06,151 labour days with total income of Rs. 58.48 lakh for the watershed labourers. The pattern of expenditure of income earned by these labourers brings out clearly that they have spent most of their income on debt repayment and consumption expenditures leaving a very meager amount for capital investment. This possibly has not led to the expected cascading effect on household income. It has brought the labourers back to the situation where they are still in need of labour employment from outside sources. People are working as labourers on stone quarries and road construction and the migration pattern is constant even after the watershed project is completed. Households have not been approaching banks or any other formal credit institutions for loans for capital goods or income generating activities. The committee mentioned that women SHGs are borrowing from banks, but this is not reflected in the household responses. The SHG loans are mainly for inputs for crops and consumption. The study reveals that providing wages to the watershed community does not automatically ensure the creation of employment or livelihood opportunities on the long-term basis. The project investment going in the hands of community needs to be deliberately mobilized towards capital investment for more sustainability.

In case of Asarkheda, about 70% of unskilled labour cost, that is, Rs. 16 lakh, is spent on use of machinery to create farm bunds combined with the farm roads. The machines are also used to carry stones for outlets. Rest of the work, such as continuous contour trenching (CCT), loose boulder structures, gabions and earthen nalla bunds were constructed with the help of labourers combined with machine for transportation of material. The technical quality of farm bunds erected in terms of cross-section, shape and alignment is slightly better where machines were used than in manual labour

works. According to VWC of Asarkheda, they decided to use machinery instead of labourers only after the experience of having very limited number of labourers on work during the first year of implementation of the project programme. The farmers have to go for dry seeding of crops in the month of May due to non-availability of labourers in the village. Only after offering the labourers the first chance of employment on watershed work, were machine used. Considering that no labour migrations incidence was noticed, and a comparatively better pre-project situation as well as capacity building of almost a quarter of the entire project period utilized towards labour mobilization. Asarkheda's decision of employing machine in the place of labourers seems justified. Given at the significant changes in the household income, crop productivity and water availability, the investment in watershed project even by way of machine use is feasible.

Cost per hectare is higher in Asarkheda as compared to that in Nandkheda. It is mentioned by the VWC of Asarkheda that machine work is cheaper than the labour cost with lesser management skills required. This does not seem to reflect from the cost per hectare incurred on area treatment. The analysis also clearly brings out the fact that the cost per hectare for crop cultivation in Asarkheda is Rs. 3,362 where mostly the machine were used as against Rs. 2,819 per ha for crop cultivation treatments in case of Nandkheda. The duration of project implementation is similar in both the cases even though Asarkheda got project investment of only about 45% of what Nandkheda has invested. The area treated is also only 36% of the total treated area in Nandkheda. The proportion of project management cost to the project measures cost is 21.5% in Nandkheda as against 26.1% in Asarkheda. Normally machine works are advocated to save cost and time of implementation saying that it is cheaper and faster to work with machine than with labourers. The study reveals that this assumption is not true in case of the study villages studied. Besides this, the cost of administering the project is higher in machine watershed than in labour watershed.

Most of the farming households make use of machinery for ploughing in Asarkheda and for threshing in Nandkheda. Nandkheda watershed committee has purchased a tractor along with farm equipments through bank loan by using its maintenance fund as guarantee of repayment. The committee hires out the tractor to the farmers for different farm operations. It maintains the watershed activities each by using the profits earned by the tractor. This is not reflect in the responses of the households and there is a question-mark on the successful functioning of the tractor hiring system even though the committee says it has repaid the loan completely. The reduced opportunity of work for agricultural labour in the kharif and rabbi season, a lower promotion of labour-intensive cropping pattern and at the same time increased farm mechanization in post watershed period have significant interrelationship. Labour intensive crops like onion, tomato etc. have the potential of creating more labour as compared to water-intensive cash crops like sugarcane, banana etc. Labour replacing technologies such as an increased number of tractors, threshing machines in the post-watershed phase are also playing a role in the reduced employment opportunities (Kerr *et. al.* 2000)

The participation and Ownership of the local community in any intervention is very crucial so as to sustain the outputs and outcomes of such interventions. In watersheds, this can be measured in terms of the level of awareness among the community with regard to concepts and issues in natural resource management. The watershed works continuously for 4-5 years, by involving the community as labourers, brought practically everybody in Nandkheda on-board in watershed project. Execution of technical treatments on ground, measurement and payment systems involving financial management by VWC and continuous churning of difficulties and issues in the meetings established and ensured a higher level of participation the people in Nandkheda in the project as compared to Asarkheda. The people also put in their labour as Shramdaan leading to more transparency in the project. Asarkheda shows a higher proportion of local contribution which does not reflect in the household-wise Shramdaan. People here have contributed very minimal in terms of their own source (labour) as against the larger value of household wise Shramdaan in Nandkheda. Hence it does it is not surprising to see lesser awareness in Asarkheda

with regards to contributing to the goal of maintaining the natural resources that are of common interest. Conflicting opinions among the people of Asarkheda about watershed may be the reason for this type of outcome as some villagers were in favour of programme whereas some were not. The reason for conflicting opinions of villagers might lie in their exclusion and/or inclusion in the process of implementation. It also reflects in lesser participation by Asarkheda people in the common meetings as compared to Nandkheda. Hence it is necessary to have all-inclusive policy for the overall success and sustainability of the project. The habit of thrashing out the developmental issues and problems through democratic processes and discussions in meetings is developed in a project like Nandkheda where human dynamics was a major part of implementation process.

Common pool resources (CPR) issues such as degradation of community land and depletion of water resources are part and parcel of community residing in the watershed areas. Asarkheda people sound instances of destruction by some people while Nandkheda brings out deforestation and overgrazing as major threats to the common land. With regard to water resource depletion, both the villagers attribute it to bad monsoon and believe it can be tackled by a ban on tube wells and high water requirement crops.

6. Scope for future research

The future line of research in the area demands undertaking policy research on the one hand and the project evaluation research on the other. Therefore, the areas of research in this direction may be; 1) Capacity assessment and utilization evaluation and the value of resources generated by watershed, 2) The impact of watershed on environmental and climate change, mitigation and adaptation, 3) Conflict between upstream and downstream villages of watershed, 4) Watershed and its linkages with rural poverty and 5) Watershed and the gap between rich and poor.

Abbreviations

CBO = Community Based Organization

FIP = Full Implementation Phase

FSR = Feasibility Study Report

GoM = Government of Maharashtra

HDI = Human Development Index

IGWDP = Indo German Watershed Development Programme

MSSM = Marathwada Sheti Sahaya Mandal

NABARD = National Bank for Agriculture & Rural Development

NGO = Non Government Organization

NREGS = National Rural Employment Guarantee Scheme

NT = Nomadic Tribes

PCR = Project Completion Report

PHC = Primary Health Centre

SC = Schedule Caste

SHG = Self Help Group

SMS = Samyukta Mahila Samittee

ST = Schedule Tribe

WOTR = Watershed Organization Trust

References

AFC-Agricultural Finance Corporation Study (1998-99).

Kharel, B.B. (1996) PWMTA-FARM Field Document No.7, Proceedings of Asian Regional Workshop Organized by the PWMTA, Netherlands/UNDP/FAO,GCP/RAS/161/NET.

D'Souzar, Marcella (1997) Gender and Watershed Development, Ag. Ren, p. 3/13.

Deshpande, R.S. and Reddy, V.R. (1991) Differential Impact of Watershed-Based Technology: Some Analytical Issues, *Indian Journal of Agricultural Economics*, 46(3): 261.

Gunawardena, E.R.N. and Jayatilake, H.W.K. (1996) PWMTA-FARM Field Document No.7, Proceedings of Asian Regional Workshop Organized by the PWMTA, Netherlands/UNDP/FAO,GCP/RAS/161/NET.

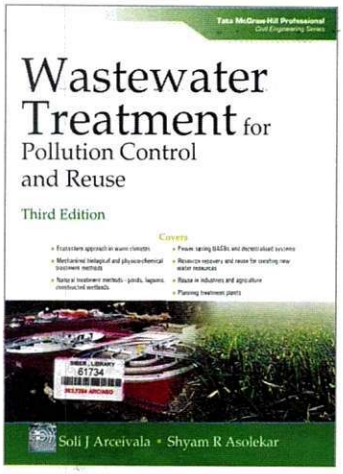
Ghulam, Habib (1996) PWMTA-FARM Field Document No.7, Proceedings of Asian Regional Workshop Organized by thePWMTA, Netherlands/UNDP/FAO,GCP/RAS/161/NET.

GoI, (2005) National Rural Employment Guarantee Act (NREGA) - A User's Guide.

GoM, Dept. of Rural Development and Water Conservation (Jul 2006) Government Resolution on Vidharbha Panlot Mission and Working guidelines of Marathwada Panlot Mission.

ICRISAT (2007) Guidelines for Planning and Implementation of Watershed Development Programme in India: A Review.

Kerr, *et al.* (2000) An evaluation of dry land watershed development projects in India, EPTD discussion paper No. 68, International Food Policy Research Institute.
Kovit Punyatrong,(1996), PWMTA-FARM Field Document No.7,Proceedings of Asian Regional Workshop Organized by the PWMTA,Netherlands/UNDP/FAO,GCP/RAS/161/NET
Lu, Shengli (1996) PWMTA-FARM Field Document No.7, Proceedings of Asian Regional Workshop Organized by the PWMTA, Netherlands/UNDP/FAO,GCP/RAS/161/NET.
Moujahed, Achouri (2003) Next Generation of Watershed Management Programes: Objectives and Expected Results,XII Forestry Congress, p. 2.
NABARD (1996) Feasibility study report of Asarkheda by MSSM.
NABARD (1996) Feasibility study report of Nandkheda by Nirman.
NABARD (2001) Project Completion Report (PCR) of Asarkheda, MSSM.
NABARD (2001) Project Completion Report (PCR) of Nandkheda, Nirman.
Sharma, R. (2002) Watershed Development: Adaptation Strategy for Climatic Change, South Asia Expert Workshop: Adaptation to Climate Change for Agricultural Productivity, Organized by UNEP, CGIAR & GoI.
Tin, U. SweLatt (1996) PWMTA-FARM Field Document No.7, Proceedings of Asian Regional Workshop Organized by the PWMTA, Netherlands/UNDP/FAO,GCP/RAS/161/NET.
WOTR, Operations Manual on Watershed Management.



Wastewater Treatment for Pollution Control and Reuse (Third Edition)

Author : Soli J. Arceivala and Shyam R. Asolekar
Publisher : Tata McGraw-Hill Publishing Company Limited, New Delhi
ISBN 13: 978-0-07-062099-5
ISBN 10: 0-07-062099-7
Pages: 518
Price: Rs. 595 /-

This new book is a first of its kind, which completely satisfies the requirements of both environmental engineering and environmental sciences students. Its comprehensive discussion concerning the need for sensitivity towards the ecological environment in the context of sustainable development is unique. Divided in seventeen convenient chapters, this book covers:

- Essential scientific, ecological and legal backgrounds
- Polluted environment: water, air and soil
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- Environmental management
- Water conservation and reuse in industries
- Sludge management
- Guidelines for planning and designing treatment plants and CETPs
- Facts about sustainable waste management

The traditional engineering areas of water, wastewater and solid waste treatment are examined in detail with fresh suggestions for solving problems of biosolids and landfill leachate. The topical concerns of hazardous and contaminated sites are discussed and the concepts of waste minimization and waste audits are introduced with particular reference to "reduce, reuse and recycle".

- The special features of the book include:
- Simple, more cost-effective wastewater treatment methods
- A section on ground water recharge
- A special section on retrofitting sanitation in slums and shantytowns
- Water conservation reuse in industries and agriculture
- Case studies of wastewater treatment plants
- Numerous problems solved throughout
- An extensive reference list and glossary
- Interesting topics for research and development

This book is for....

The book is designed for the faculty as well as graduate students of environmental science and management, civil and chemical engineering. It also serves as a text in elective subject of environmental engineering to allied engineering fields at the under graduate level. These include - civil, chemical, mechanical, agriculture and food technology. Students of environmental science and management should find a wide range of material covered and its quantitative nature will benefit them. The quantitative approach with mathematical foundation and numerous examples and homework problems is essential for transition to environmental engineering. The book can also be of use to professionals from the industry as well as to consulting firms concerned with the control of water pollution and management, and reuse of wastewater. Information useful to pollution control agencies, municipal corporations and town planning department is also included.

The book contains....

The book starts with ecosystem approach to pollution control as its first chapter. It highlights the overall review of wastewater management in India with reference to wastewater characteristics and environmental impact assessment; and ends with strategies for control of pollution. The chapter is basically designed to introduce the environmental science, management and engineering students to the need for sensitivity towards the ecological environment. Most of the traditional engineering books are devoid of ecology studies. The second chapter is devoted to planning for wastewater collection and treatment. It also contains a detailed discussion on the choice of wastewater treatment methods, newer approach in wastewater collection and initial planning.

After providing an insight regarding the ecology/ecosystems concept in relation to control of pollution in the first component; the second major component deals with the aerobic biological treatment. In this, the design and choice of reactor is given in chapter three; while the next three chapters are dedicated to aerobic biological treatment methods, principles of aeration and principles of aerobic biological treatment. These chapters provide details regarding various types of activated sludge processes, its oxygen requirement and related calculations. Nutrient removal from waste is discussed in-depth.

Up-flow anaerobic sludge blanket (UASB) digester and other anaerobic treatment processes have been dealt within chapter seven. It includes the review of UASB in India, its design parameters, gas recovery and commissioning of plant. Chapter eight deal with aerated lagoons, their types and design considerations. Detailed discussion is also given on the constructional features of the lagoons.

In the recent times, wastewater treatment by natural systems is gaining immense importance due to their various advantages. The next three chapters (from nine to eleven) deal with such aspects of wastewater treatment. It includes algal pond, hyacinth and duckweed ponds, fishponds, natural and constructed wetlands, vermiculture and ultimate use of treated wastewater for irrigation as treatment method. The information regarding design criteria, operation, maintenance and monitoring are also made available in a simple manner. Advanced treatment methods like ion exchange, carbon adsorption, disinfections and membrane processes have been discussed in chapter twelve. Some pages in this chapter are devoted for discussion on combined biological and physical-chemical treatment methods.

Management of sludge is an integral part of any wastewater treatment system. Chapter thirteen mainly concerns itself with solids settling and sludge management from wastewater treatment processes. The sludge composition, treatment and disposal are discussed from the point of view of ecologically sound disposal methods. Negative consequence of better wastewater treatment and better standards of liquid effluent is the key for generation of huge volumes of sludge. With the elimination of sea disposal route and the tightening up of lands spreading as a disposal method, innovative treatment and disposal methods are urgently required. Sludge and its fate are topical issues. By definition, 'clean sludge' and its use as a soil conditioner leads to alternative uses such as forest fertilizers, land reclamation, sacrificial land application and landscaping. The chapter examines such possibilities. Chapters fourteen and fifteen

covers water conservation and reuse in industry and agriculture along with water reuse in public water supplies. The chapter also highlights the recharging of ground water and deliberates on EIA process.

As far as the beginners in the field of wastewater treatment are concerned, it is essential for them to have an insight regarding planning and design of treatment plants along with the common effluent treatment plants (CETPs). The next two chapters, sixteen and seventeen deal with these aspects. Their content is related to waste minimization, life-cycle assessment and clean technologies. Normally, priority is given to waste minimization, particularly in relation to industry and its waste products in environmental planning.

References as well as material for further reading are cited substantially at the end of each chapter for the benefit of readers. Indexing is carried out for all the important terms used in the textbook.

The book contains enormous data in tabular and graphical form and illustrations, which help the readers understand the content easily and in-depth. The language used is very lucid and easy to understand.

In today's context, environmental engineering is a challenging development in interdisciplinary/multidisciplinary disciplines, particularly for the student community. It is now necessary that the environmental engineering/science undergraduates be exposed to the non-engineering environmental disciplines i.e. social sciences and law during the academic years. They then would not only be capable of negotiating with non-engineering professionals but would also be sensitive, in their own right, to other key players like public in environmental debates. Environmental engineering today addresses problems in water, air and soil environments. The book will open up new horizons for the students with aforesaid basic topics of relevance. The book contents form useful deliberations on such topics as ecology, microbiology, groundwater, solid waste, environmental impact assessment, and environmental management.

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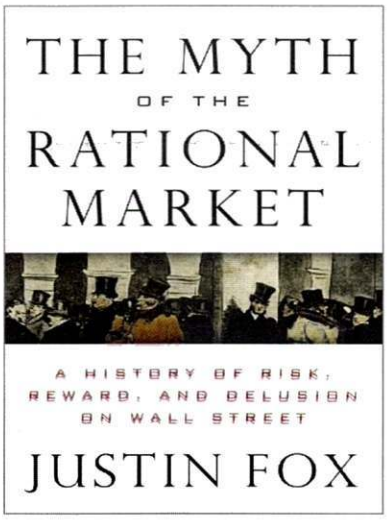

The Myth of the Rational Market

Author : Justin Fox
Publisher : Harper Business
Pages : 392
Price : $27.99

The world economy is passing through a phase of severe recession. The consequences of the economic crisis are also being experienced in India. The output in all the contributing sectors has been declining in the recent past. The excess of inventories, are resulting in unemployment and idle resources. These events world over are considered to be the result of undue faith of the policy makers on the "Efficient Market Hypothesis".

The book by Justin Fox, entitled, "The Myth of the Rational Market" has come at an appropriate time, when the world is questioning the fundamental framework of policy making, especially in the last two decades. The author provides a good description about how the idea of rational markets evolved and became the guiding principle for national and international policy makers. The advances in Mathematical Economics provided greater impetus to the propositions of the free market. The belief in these ideas led to the creation of new financial products, derivatives, sub-prime mortgages etc. The financial innovations were seen as means to exploit the wonders of free market mechanism. But the collapse of the world market proved that markets can never be rational. Even the former chairman of Federal Reserve, Alan Greenspan admitted that the entire intellectual structure had collapsed due to the economic crisis. In the book one finds a description of how these ideas evolved in the academic and policy circles. The author also puts on record the shift away from the proposition of the free markets by academicians almost 20 years back. Infact, the focus of the researchers has shifted to explain the ways in which the markets behave irrationally

The book is a must read for academicians, policy makers and management students, who are interested in understanding the dynamics of the current events in the macro environment. The book also provides an answer to all the critiques of the heavy bail out packages, which the government in almost all the countries of the world are depending on, to overcome the crises. It provides the base for understanding the shift in the policy stance of the different national governments. The only limitation is that one cannot find any solution being put forward for the current world problems.

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Starbuck, W.H. & Mezias, J.M. (1996) Opening Pandora's box: Studying the accuracy of managers' perceptions. *Journal of Organisational Behaviour,* 17:99-117.

Book reference

Cummins, Thomas G. & Huse, Edger E. (1998) Organisational Development and Change. West Publishing Company, St. Paul, New York.

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