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(Utilizing) the Influences of Chaos for Effective Environmental Management of the Vavuniya Urban Council

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Abstract

This paper is based on the **hypothesis** that the (expansion of) human population is the major factor of influence affecting the effectivity of the environmental management system/s in any urban centre; hence the population increase in the system is directly proportional to the environmental management problems. The Vavuniya Urban Council underwent a massive change due to the large influxes of human displacement in the 1990s and the early parts of the 2000s – as a consequence of civil war related human displacement. This resulted in the unexpected or chaotic increase in the local population. As a consequence of this, the competition for the utilization of natural resources has/d increased drastically within the urban council limits – which have even created a state of chaos. This paper produces the argument that, if the elements of non-linearity and chaos prevailing within the Vavuniya

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Urban Council area are understood based on the holistic approaches prescribed by the 'Gaia' doctrine, then it becomes actually possible to effectively manage the environment through: *(a).* finding out the sensitive points of origins of chaotic situations and controlling/eradicating (or finding alternatives to) them, *(b).* administering external shocks to the chaotic system so as to induce possibilities of self-regulation and, *(c).* changing the orbits of the chaotic loops.

[*Key Words*: chaos, management, environment, strategy, non-linearity]

1.0 Introduction

Any system that is in equilibrium is capable of absorbing shocks effectively and (is capable of) developing resilience to the negative impacts induced by the said shock. For example, in an ideal urban environmental management system (in equilibrium) the effects of a heavy isolated storm will be zero, as the system will have effective urban drainage methods. Environmental management in almost all the urban areas in Sri Lanka are far from these ideal conditions and suffer from a multitude of environmental issues resulting (mainly as a consequence) of mismanagement or due to the **lack** of appropriate management methods. Mismanagement is bound to occur whenever the local environmental management system experiences a change that is beyond its capacity. The Vavuniya Urban Council underwent a massive change due to the large influxes of human displacement in the 1990s and the early parts of the 2000s – as a consequence of civil war related human displacement. This resulted in the unexpected or chaotic increase in the local population. As a consequence of this, the competition for the utilization of natural resources has/d increased drastically within the urban council limits – which have even created a state of chaos. The aim of this paper is to critically examine the state of chaos prevailing in the environmental management framework of the Vavuniya Town and to explore the possibilities of developing an improved/revised management strategy that would be capable enough for effectively minimizing the effects of chaos.

This analysis is based on the **hypothesis** that the (expansion of) human population is the major factor of influence affecting the effectivity

of the environmental management system/s in any urban centre; hence the population increase in the system is directly proportional to the environmental management problems.

An important **derivative** of this hypothesis is that when the population of an urban centre is in a condition of norm (within the limits of its carrying capacity) the existing environmental management strategies would/could be adequate. However an unexpected population influx will create a state of chaos and cause rapid environmental deterioration. The states of chaos allow no space for the local environmental management system to respond to the changes and evolve so as to be able to manage the consequences effectively. The reader (of this article) might have wondered why the title of this paper has been stated as: '(Utilizing) the influences of chaos for effective environmental management of the Vavuniya Urban Council' - with the word **utilizing** bounded by brackets? A simple answer at these points could be that a carefully controlled and managed effort is necessary – if we are to deal effectively with chaos. Hence, the brackets have been used – as a verbal model to explain the hypothesis.

2.0 Methodology

Conceptual understanding of the environmental management problems was developed using the application of theories, scientific reasoning and conceptual modelling techniques in the analysis. Theory is represented as a logical construction comprising propositions, some of which contain established information while other defines questions. The working part of the theory provides the information and logical basis of for making generalization (Ford, 2002) – and for generating further hypotheses/theories.

Field observations and investigations were also carried out for developing an *in-situ* understanding of the problem of concern. The methods included in the field investigation component were: observation/s (both visual and impact oriented), interviews and discussions. Visual observations focused on the problems and facts that are observed by the investigators.

The researchers interviewed local people, residents and local Government of Sri Lanka – Departmental Heads (and other officials) who are key stakeholders to the problem of concern. This was done so as to know the perspectives, concepts and problems of the key stakeholders and also to collect any other valuable archived data they would provide.

As such, secondary data was collected from the Statistical Records held by the relevant departments in the district, using discussions and interviews as a venue for approaching the relevant stakeholder to produce characterized and archived (quantitative or qualitative) data. Some data were gathered from the Statistical Hand Book for the Vavuniya District (2006/7).

Then using the concept of chaos and its system perturbation properties, the present environmental degradatory (or mismanagement) trends prevailing in the Vavuniya Urban Council were evaluated. Once the grey areas, missing links and possible remedies were finalized, the possibilities of developing an improved/revised management strategy were evaluated through the development of a log framework matrix. The Log frame matrix (presented in Appendix - 1) has five columns and it presents the suggested framework for successful environmental management of the present chaotic situation/s of the Vavuniya urban area, through:

1. finding out the sensitive points of origins of chaotic situations and controlling/eradicating (or finding alternatives to) them,
2. administering external shocks to the chaotic system so as to induce possibilities of self-regulation and,
3. changing the orbits of the chaotic loops.

These are discussed in the forthcoming sections. As such, the **unique** and **novel** aspect/s of this paper can be stated as the fact that it attempts to understand the situation of unpredictability (which is a common problem that is left unresolved in management science) and, application of the *chaos theory* (and its *principles*) to control/mitigate it – for effective environmental management in the Vavuniya Urban Council area.

3.0 A Critical Analysis of the Present Environmental Management System of the Vavuniya Urban Council area

Urban centres (all over the world) are suffering by rapid-urbanization, which means drastically increased population densities and heavy industrialization that is often beyond the carrying capacity of the urban canters.

The Vavuniya town is the administrative and commercial capital of the Vavuniya District. This township has operated as a key transit point in the movement of the people and goods (from the southern parts to the north of the country and *vice versa*) because of the road network (or the important nodes) that interconnect the north and south and east to west as well*. The Vavuniya urban council is the administrative body that manages this township. Vavuniya town (in essence) has been planned as a small town (hence the Urban Council and not the Municipality) for carrying a (very) small urban population.

Before the 1990s the Vavuniya Urban Council was relatively stable in the sustainable utilization of natural resources with natural forest reservations and thirty networked manmade tanks (combined to form the cascade system). Due to the population increases occurring in the 90s and the early part of the 2000s - due to mass displacements induced by the civil war, demand/s for land increased and caused the depletion of all its forest cover and destruction of certain tanks (e.g: the Thirunavatkulam area and Urban Council building area/s in Park Road were tank beds previously). Since, there are no perennial rivers in Vavuniya, it is essential that all the tanks comprising of the cascade system are maintained well – to ensure efficient recharge of the groundwater resources in the locality.

At this point, it can be argued that: *since the Vavuniya town (by design) was not planned as a BIG town; the Urban Council management*

* Vavuniya town was the only entry point to the Vanni region about 50 years ago (p*ers. comm*: Mr. S. Sathasivam, The very-first secretary of the Town Council of Vavuniya, 1948, who is now 98 years old). Actually in earlier stages both Mullaithivu and Vavuniya were a single district named as Mullaithivu district. At that time Vavuniya functioned as a sub-town of Mullaithivu and connecting path way for north part of the island (Vanni and Jaffna).

is/was incapable of accommodating the unexpected influx of population that resulted in a chaotic situation for natural resource utilisation/consumption. Further, it can also be stated that*, since the present environmental strategy is not capable of adjusting to and consequently/eventually managing the chaotic situation; sustainable development – can* ***NOT*** *be achieved fully.*

The Vavuniya district had a population* of 180, 949 persons as at 31st May 2005 where more-than half of them are internally displaced people (Vavuniya District Planning Secretariat, 2006). **This is double the amount than 1981 census.** The displacement occurring from the Vanni and northern regions as a result of civil conflicts during 1990, 91, 95, 98 increased the population in the Vavuniya divisional secretariat division and the Vavuniya Town (to explodable proportions). The Vavuniya Urban Council did all the necessary assistance to accommodate most of them (Urban Council Program Budget, 1998) – within its capacities. As a durable solution to these displacements, 36 relocation villages have been established within the period of 1995 to 2004 and other renovation projects were implemented. Officially, about 6% of the (district's) forest cover was deforested under these projects (Vavuniya Plan, 1998).

The extent of Urban Council area is 22.2 square kilometres. There are eight minor tanks and one major tank present within the Urban Council limits. Major part of the urban land is used for agriculture (44.2%) and residential purpose (19.8%). 14% of the existing land contains water bodies (Sathiyanathan, 1997). Production sectors are mainly agriculture and life stocks, which contributes to the main stay of the economy. Minor Industries and trade services support about 15% of total employment in the district. It is suspected that the settlement of the internally displaced people has contributed to a decrease in the agriculture land and water bodies and increase in residential and institutional land use.

It was estimated (in 1997) that the Vavuniya town generates more than 10 tons of solid waste *per* day (Sathiyanathan,1997). Urban Council tractors are (in theory) collecting the wastes with out segregation from the wards. However, it is seen and observed** that in the wards of

* This was estimated, source: District Statistical Hand Book, 2005.

** At the time of writing this paper (that is during - Oct 2007).

Thandikulam, Thirunavatkulam and inner areas of the Pandarikulam Ward the collection service of Urban Council tractors is not available. The urban council reasons out for this mishap by stating that it is at present running with a shortage of man power, finances and machinery. Quite recently, wastes produced in the household levels in Thandikulam are observed to be dumped and burnt on the tank beds by the residents. Generally, the *organic* wastes collected by the council, are used to make compost as part of the Urban Council's **green** mandate. Another huge amount is disposed in open dump about 16 to 20 km away from the town (in the landfill [or dumping] site at *Pambaimadu* area). Here, hazardous (battery, lead plates) and bio wastes (i.e. discarded teeth, root channels from hospitals/clinics) are collected with normal household wastes.

At present, the environmental problems (of the *unexpected* and *uncontrollable* nature) in the Vavuniya Urban Council can be summarized as follows, [which are the direct consequences of civil conflict and the sudden population increase due to the internal displaced persons into the area]:

1. Loss of agricultural land
2. Increased waste generation
3. Tank bed encroachments
4. Deforestation – in reality there is no forest land in the urban area even though in theory reservations have been designated by the government.
5. Improper drainage - wastewater problem, water stagnation and, flooding
6. Ground water shortages
7. Decreases to the biodiversity in the local ecology - i.e. birds and other species.

The management of these problems is effected/influenced by many social and resource allocation/sharing conflicts due to the war situation. These can be classified as:

1. Misguided Urban Council governance and management practices.

2. Lack of appropriate law and order
3. Present situation of civil conflict
4. Lack of conscious* (and foresight) of people and administration
5. Inadequate finite resource
6. Inappropriate and inadequate application of appropriate technology and planning.

In the context of this paper, we see that the sudden unexpected population influx into the small urban area (of the Vavuniya UC limits) will induce negative effects on the natural resources of the system; affect the management strategies and also the supporting economic system.

Managing these problems is difficult for the local administrators because of the lack of alternative strategic plans to cater to this disordered (and chaotic) situation. These problems are causing very high levels of uncertainty in the environmental sustainability of the Vavuniya urban council limits. Developing understandings of these problems and the element of 'uncertainty' are of significant concern for developing effective and appropriate (alternative) environmental management strategies.

From the system perspective the super system of the Vavuniya Urban Council area contains the land system, the hydrological system, the atmospheric system and the social system. All of these systems combined together by complex interlinking processes contribute to the super-system's dynamics. Environmental systems are self-regulating systems: that is - when they are not disturbed beyond the limits, they can manage their disequilibria within their own capacities. But, these processes are non linear. Non-linear processes are difficult to control and manage. Therefore, effective and appropriate non-linear system management is necessary for the efficient management of the (inherently complex) environment.

An inherent characteristic of non-linear systems is their tendency to behave in 'unpredictable' ways. The prediction of the unexpected can

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* Conscious in this sense refers to how the people (and local businesses or organisations) perceive, feel about and relate to the local environment. This is highly in correlation with the *'sense of belonging'*.

be assessed by understanding the essence of unpredictability or **chaos** and its spheres of influence. Chaos is defined as the irregular, uncertain, discontinuous aspect of change within the confines of a patterned whole (Merry, 1995). Understanding chaos (or developing even a *basic appreciation* for it) provides usefulness for predicting and understanding (as well as managing) the complexity of a system.

4.0 Application of the Chaos Theory to Understand the Dynamics of Environmental Problems in the Vavuniya Urban Council

Chaos theory describes the behaviour of certain nonlinear dynamical systems that under certain conditions exhibit dynamics that are sensitive to initial conditions (popularly referred to as the '**butterfly effect**'). As a result of this sensitivity, the behaviour of chaotic systems appears to be random, because of an exponential growth of errors in the initial conditions. This happens even though these systems are deterministic in the sense that their future dynamics are well defined by their initial conditions and there are no random elements involved. This behaviour is known as **deterministic chaos**.

This new appreciation for chaos has led to an understanding of both the non-linearity of the world in which we live and of the functional aspects of instability as a means for adapting to new situations. Chaos is one possible result of the dynamics of non-linear systems. In nonlinear systems, the outcomes are subject to high levels of uncertainty and unpredictability. In nonlinear systems: behaviour is erratic and filled with surprises (Kiel, 1992).

This (theory) can be applied in the environmental management i.e. population dynamics and its consequences on resource availability, environmental costs and related environmental accounting problems.

Due to the present changes, the environmental management system within the Vavuniya Urban Council faces an element of chaos (as explained in the previous sections) and, the reason why the management of the council has failed to control this chaotic element is due to the fact linear approaches (to management) are ineffective to control these circular and complex behavioural patterns.

In an ideal environmental management context, the manger should be able to detect how change occurs in the environment and, how

environmental parameters evolve over time. One principle of nonlinear dynamics is that complex systems defy simple formulation and thus may preclude the development of precise mathematical algorithms. Nonlinear systems exhibit three distinct types of behaviour over time. These behaviours are labelled as:

1. Convergence to stability or equilibrium;
2. Stable oscillation; and
3. Chaotic.

Each behaviour can appear over the long-term behaviour/al trend of a nonlinear system. The simplest type of time-based behaviour generated by nonlinear systems is convergence to a stability or equilibrium. This behaviour occurs when we start from an initial point that quickly reaches and maintains a mathematically stable point (see figure 01). Normally it is shown in population dynamics in specific ecological niche other than human population. It is highly of predictable nature hence easy to manage.

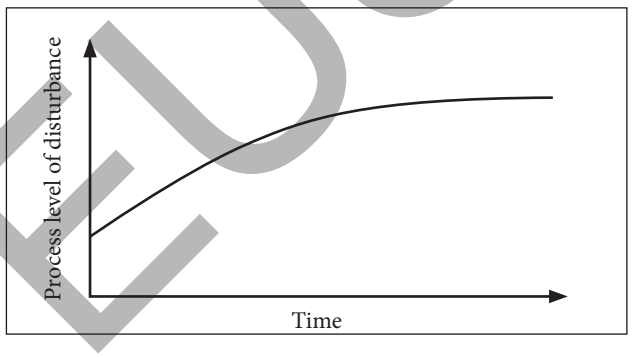

Figure 1: Convergence to stability

A second type of nonlinear behaviour that can occur in the environmental management system is rhythmic or oscillatory behaviour. This type of behaviour is generally labelled as stable oscillation because work output, such as, emergency service responses to citizens calls shift fluidly up and down in a patterned and stable fashion (see figure 2).

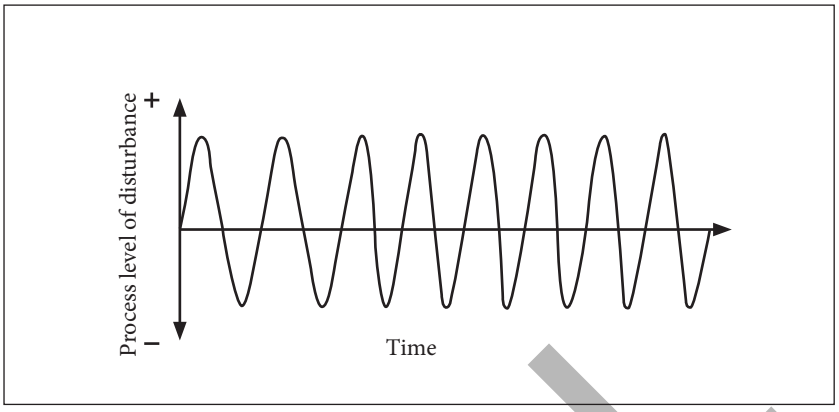

Figure 2: Stable oscillations

For example, the water demand is changing in a bimodal pattern in correlation with the rainfall patterns in Vavuniya (i.e. in the dry season more demand for ground water and, in the wet season less demand for ground water). One can imagine many agency and organizational systems relevant to emergency management that operate in such a cyclical manner. For example, calls for local emergency mobile water supply services are generally cyclical and rhythmic: messy and noisy, but rhythmic and continuous (Kiel, 1992).

A third type of nonlinear behaviour that can be expected in the environmental management is chaotic behaviour because of its sensitive nature. Chaos is typified by behaviour that, over time, appears random and disorderly (see figure 3). Chaos does, however, occur within definable parameters or mathematical boundaries. Thus chaotic behaviour remains within boundaries or within limits. It is not random behaviour that can result in any outcome. Chaotic behaviour looks wild and erratic, but does not jump out of defined mathematical limits. Therefore, it is logical to conclude the systematic understanding of chaos in environmental management is very much possible with some training and appreciation for chaos itself.

As such, the **Chaos Theory**, also called **nonlinear systems theory**, provides new insights into processes previously thought to be unpredictable and random (Richard and Edward,1995).

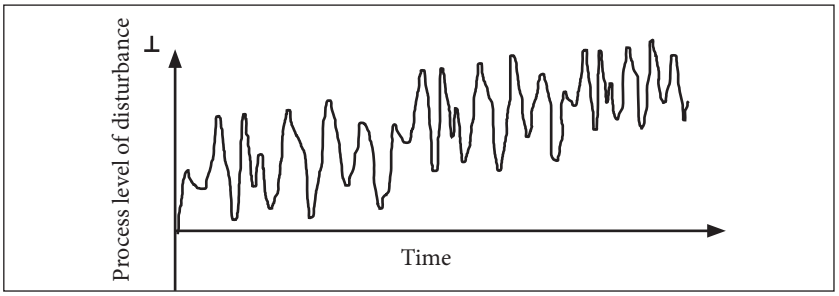

Figure 3: Chaotic situations.

When chaos occurs, a nonlinear system does not go back over prior identifiable sequences of behaviour and does not show obvious patterns in its behaviour. Thus chaotic behaviour thus appears extremely disorderly since patterns over time, a symbol of orderliness, do not appear to exist. Chaotic behaviour simply skips from one identifiable point to the next, yet never extends outside clear and distinct boundaries i.e. land value increases in the Vavuniya town are totally unpredictable, disorderly and show no patterns. The graph however shows that the data points in figure 3 do not extend beyond 0 or 1. That is using the example of property prices in Vavuniya it can be argued that the prices event-though behaving unpredictably, they will definitely not exceed the carrying capacity of the economic system (of the locality). Chaos thus looks like random behaviour but is really unstable behaviour over time that stays **within clear boundaries**.

Although chaotic time paths may look random they are generated by deterministic and rather simple mathematics. Thus the kind of chaos we see in figure 3 is referred to as '*deterministic chaos**'. It appears that organizational systems and processes that are intended to be very mechanical and simple can create such deterministic chaos and, from the context of this paper this is very true in the case of the Vavuniya Urban Council.

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* A word of caution is necessary at this point. To verify the existence of real mathematical chaos in organizational data requires the use of some very sophisticated statistical methods. So analysts need to be careful not to call all "messy" looking time series data as chaotic. Time series data may be nonlinear but not chaotic. So we must be sure to note when we are discussing real verifiable chaos or chaos as a metaphor. Surely, both approaches can help us attain the vision of the paradigm of nonlinear dynamics (Kiel, 1992).

Kiel (1992) states two important consequences that could occur:

1. First, this means that work systems or processes with few parts and simple interactions can generate very complex data that look erratic and chaotic over time. For managers, the effort to simplify processes may result in unexpected complexity.
2. Second, if simple systems can generate complex behaviour then imagine what may result when considering the complex organizations and environments that disaster and emergency services managers attempt to handle.

Systems functioning in chaotic regimes may show an inclination to be highly sensitive to their initial conditions. This means that small changes or errors can have amplified effects. For example, the lack of foresight in designing waste collection rosters in the Vavuniya Urban Council leading to a state of critical waste management problems.

4.0 Deterministic Chaotic Analysis and Understanding in the Context of the Vavuniya Urban Council

To examine the *order within chaos* in organizational management we can examine the *attractor* of time series data. An attractor is a graphical method chaos researchers use to determine how much change is occurring in the system over time. The attractor presents an image of all of the change in the data that work process data or employee performance data generate. By viewing this attractor we can begin to see the unusual and unique forms of order that the data in organizations create.

Understanding the functions of chaos reveals that chaos represents both risk and opportunity. The risk of chaos is that a system may not reach another point of stability and thus be overwhelmed by constant uncertainty and instability. This may cause extinction in environmental resources and form of resource. The opportunity of chaos is that *new ways of behaving and responding to environmental challenges may be developed and become essential elements of emergent ways of responding to an uncertain world*.

5.0 Chaos Management

Since continuous chaos, in environmental parameter fluctuations, would crush our capacity to bring any level of even minimal sustainable liveability to our population's methods for controlling chaos, as such, bringing some order to this disorder is necessary. Natural scientists have for the last several years examined methods for controlling or managing chaos (Ott, *et al*,, 1990). These efforts have resulted in three fundamental methods for controlling chaos. Three fundamental methods for managing chaos are suggested by Ott *et al.,* (1990) and Ditto and Pecora, (1993) – as follows:

1. **Alter the parameters of the system:** Factors that limiting the degrees of freedom or the extent of the behaviour available to a system. In short, by compressing down on the parameters of behaviour, the hope is to alter behaviour and create greater stability and predictability. In a heavy environmental pollution situation such as 'global warming' these degrees of freedom are often beyond the control of human actors.
2. **'Perturbations' or disturbances:** during chaotic situations to change behaviour back to more predictable and smoother functioning. This refers to the sensitivity of chaos to small changes. The intent with such interventions is to use small change that creates nonlinear effects that create phase shifts from erratic behaviour to more fluid behaviour. In environmental management this can be applied through the legislative mechanism and enforcement power to control the system.
3. A third and most recent method for controlling chaos is aimed at **altering the orbit of a chaotic to system** to a more desirable orbit on its attractor (Ditto and Pecora, 1993). This approach uses continuous tracking and seeks to identify changes in system behaviour that occur over time. By tracking such changes alteration of the parameters are expedited. This can be through environmental monitoring system using available technology such as chemical analysis, remote sensing and Multi Criteria Evaluation.

The perspective through the Chaos theory gives an enhanced and comprehensive understanding of the environment and paves way for developing effective management strategies. It is shows that the world is actually filled with flux and change. All the systems are marching to their own unique rhythms within their limits. Further, if the manager understands the systems, their nature, rhythms and behaviour well – then it becomes possible for him/her to device strategies for effective management despite how badly the system is perturbed by external influences*. This becomes possible through the understanding of chaos, which enables new ways of behaving and responding to environmental challenges to be developed. These, in turn, become essential elements of emergent ways of responding to an (*essentially*) uncertain world.

6.0 Management Strategy/Model

The management of urban environment consists of utilization of *natural resources*, *human resources* and other; *processes*, that convert these resources into various other useable products and services; and *effects* of these processes, which may be negative or positive. If these effects are not coordinated, the system becomes chaotic so that the environment may change its structure and functions in a completely unpredictable manner. In these instances, development of the appropriate management strategy should include the methods stated by Ott, *et al.*, (1990) and Ditto and Pecora, (1993).

In developing the appropriate management strategy, the manager should include environmental modelling (to assess plausible management scenarios), environmental monitoring (as a feedback and correction measure/loop/element) and the establishing of appropriate **environmental management systems** (EMS). The EMS should have relevant (legislative) enforcement power and an effective framework or action plan.

7.0 Conclusion

Vavuniya town (by design) was not planned as a BIG town; the Urban Council management is/was incapable of accommodating the

* Provided that the limits of tolerance are not exceeded.

unexpected influx of population that resulted in a chaotic situation for natural resource utilisation/consumption. Further, it can also be stated that, since the present environmental strategy is not capable of adjusting to and consequently/eventually managing the chaotic situation; sustainable development – can not be achieved fully. We argue that, if the elements of non-linearity and chaos prevailing within the Urban Council area are understood based on the holistic approaches prescribed by the system's concept then it becomes actually possible to effectively manage the environment through (see appendices 1 and 2):

- finding out the sensitive points of origins of chaotic situations and controlling/eradicating (or finding alternatives to) them,
- administering external shocks to the chaotic system so as to induce possibilities of self-regulation and,
- changing the orbits of the chaotic loops.

This paper has established the need to focus on chaos prevailing within an EMS (environmental management system) for the effective development of the appropriate management strategies. However, a quantitative-qualitative conclusion is beyond the scope of this predominantly conceptually-structured research paper.

As such, further research in these regards should focus on acquiring qualitative/quantitative data to establish the hypothesis set in this paper. Moreover, since the need for controlling the element of chaos is understood, future research should also look at developing a modelling approach where plausible management scenarios can be simulated for the efficient development of the appropriate management strategies. Inthese regards, the usage of the Stella platform (an icon-based logical modelling language) - which is ideal for developing MCE models capable performing simulations recommended by the authors. Therefore, to conclude, it can be stated that the influences of chaos have to be carefully **utilized** for effective environmental management of the Vavuniya Urban Council' from a careful systemic perspective. That is, **chaos** should be carefully (utilized)!

Appendix 1: Log-frame work for effective management of the chaotic environment by the Vavuniya Urban Council

Activity description	Indicators	Assumptions	Specific tasks of the Urban Council	Targets to be achieved
Goal: Reduce the chaotic environmental situation in the urban council area and improve the conservation and sustainable utilization of the natural resources by effective environmental management strategies.	The economic and environmental problems are reduced, environmental sustainability indicators such as - life quality index increases, financial sustainability increases, environmental quality increases, land property value becomes normalized, population becomes stable (or is stabilized).	The EMS will be perfectly implemented. The responsiveness and adaptability to 'environmental change' will be increased in all the level.	A proper comprehensive integrated adaptable environmental system should be implemented.	Increased the stable environmental situation in the Urban Council area.
Purpose or outcome: State of the environment becomes normalised (in relative equilibrium) and confirms to the sustainable resource conservation/ utilisation process.	Population remains stable (controlled and managed), Tanks are full of water, wastes reduced, pollution free environment, illegal dumping of wastes checked, re-vegetation of destroyed reserve lands initiated.	Country situation is normal, legal enforcement; financial status and social status are balanced and, management activities performed in an effective manner.	Proper sustainable financial planning and management. Effective legislation powers and initiating/implementing successful capacity building and awareness programmes.	Financial sustainability, increased/enhanced environmental legislation powers, proper and improved management activities.
Component objectives or intermediate results: 1. The awareness or consciousness about the environmental management problem should increase in all stakeholder levels. 2. The system understanding of the environment is improved. 3. The integrated effective environmental management system should be implemented. 4. The legal enforcement and, law-and-order should be effective[1] . 5. Controlling land permitting and illegal encroachments 6. Continuous environmental monitoring system should implemented (that mean include appropriate technology at least within local limits of management capacity).	1. Environmental problems and mitigations are discussed at all the societal levels. 2. The perspective on environmental management changed. 3. The decision making process are done with all stakeholder participation. 4. Immediate and stricter actions by relevant authority. 5. Periodical review on the processes and environmental actions. 6. Illegal encroachments are stopped. 7. The environmental audit and logs are created. The findings and results are published 8. New management strategies are implemented. 9. Continues environmental monitoring system was implemented. 10.The enforcement of legislative power and administrative power have increased.	1. The awareness strategies implemented and the goals achieved 2. All the stakeholders are actively participating in all the process. 3. There is continues monitoring in function. 4. Research and evaluation is done using proper inductive methodologies. 5. The authorities are functioning in a responsible manner.	1. Committee makes periodical review meetings. 2. Conduct research in relevant problems in this regard (Vavuniya Campus can play a major role). 3. Proposing planning & zoning activities. 4. The enhanced Environmental Monitoring System[2] should include GIS, remote sensing, pollution monitoring (can be implemented within in their limits).	Meeting minutes are amended and reviewed to generate improvements to the management. Research review meetings held and, the findings are published so that they are available to the public. Plans are drafted with foresight and system understanding.

7. The research and evaluation of the environmental management conducted in a scientific manner (mainly it should be based on the inductive reasoning research methodologies). 8. Administering external shocks to the chaotic system so as to induce possibilities of self-regulation.				
Outputs: 1. The state of environment becomes normalised, the resources are plenty for all and there is ensured environmental sustainability. 2. Small Tanks in the urban council area are renovated. 3. Illegal encroachments and issue of illegal land permits are prevented. 4. Waste management facilities are increased. 5. Proper drainage design/construction implemented and executed. 6. Revision to housing plans and urban dwelling designs.	1. A sustainable environment is created. 2. Tanks are rehabilitated and well capacitated. 3. A waste free clean healthy environment unfolds. 4. No drainage blocks, flooding, waste water stagnation.	1. All the resource utilizations are in sustainable manner. 2. Tanks are not encroached and proper management. 3. Authorities properly manage wastes. 4. Planning and implementation will be in an integrative and adaptable manner.	Establishing integrated environmental management systems. The members of the Urban Council management body should involve representatives from all stakeholder levels - for enabling the open exchange of information between officers, researchers, managers, politicians and local public.	The mgt. committee will formed

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