Time and the Ganga River at Asi Ghat, Banaras: Pilgrimage and Ritual Landscape

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ABSTRACT
During 0600 mornings between November 1999 and May 2001 we made hourly counts of visitors to Asi Ghat, the southernmost ghat along the Ganga in Varanasi. More than 1.3 million pilgrims and bathers were recorded during this period. The numbers of such visitors peak sharply during festivals, as pilgrims clearly watch the lunar-solar calendar very closely to establish the correct dates. There is a remarkable connectivity from year to year for certain festivals. For example on the day of Shivaratri, when an average of 22,500 came to Asi Ghat, there was a difference of total numbers of only 7% between 1999 and 2000. On days when more than 300 people arrive per hour at Asi Ghat, the numbers of visitors follow a power law distribution, similar to that of many of the self-organised systems of the natural world. With a catchment basin that includes most if not all of the sub-continent of India, the pilgrimage system of Varanasi behaves at times as large living organism, with energy flows due to human movement and specific patterns of behaviour. During the greatest festivals when more than 2500 people arrive per hour, the self-organisation of the Varanasi pilgrimage system intensifies partially due to increased mutual interaction of pilgrims who arrive in informal groups of family and friends or various kinds of pilgrimage tours. On non-festival days, especially in the cool mornings of winter, there may be fewer than 300 people arriving per hour, and there is no evidence of such a self-organised system.

Kashi as a Tirtha

Varanasi, the holiest city of Hinduism and Kashi, its sacred center, have been the object of a vast collection of literature and mythology. Recent analysis of phosphates in the soils of Varanasi suggest an age of 2800 years, which makes it one of the most ancient and continuously occupied cities of the world. (Eidt 1977) Lying on the west bank of the Ganga, the city is an ancient *tirtha,* a "crossing-over" place, where heaven and earth meet, providing access for humans to the gods and a route for the gods to enter the human realm. Together with Prayaga and Gaya, Varanasi is one of the three great tirthas of India. (Singh 1987; Eck 1983)

The word *tirtha* is derived from the Sanskrit root *tr* meaning to ford or cross a river. Tirtha initially designated a place where a river was fordable, which was initially chosen entirely for its practical value. While crossing travelers might take a bath, either intentionally or inadvertently. Since the act of bathing has such great ritual significance for Hindu, many tirthas denote a spot on a river where the act of taking a bath had a very special importance. The significance of a particular tirtha, such as Varanasi, would have been established through the accumulation of historical events associated with countless generations of travelers crossing a river at a particular spot; thus travelers might camp on the banks prior to crossing; traders, merchants, priests may congregate there to provide services for the travelers. Not by coincidence, the Grand Trunk Road sweeping across northern India between Calcutta and Delhi fords the Ganga at Varanasi. Over the millennia the build-up of layer upon layer of memory would sanctify the spot. With time in Hindu India, the presence of a river was not necessary, and the term tirtha was extended to any holy spot, with or without water, that affords an opportunity for crossing over between realms of earth and heaven. The gods come down and humans ascend.

The most famous descent into Varanasi was by Lord Shiva, the mountain ascetic, who needed to find a suitable home for himself and his bride Parvati, daughter of the Himalayas. He scanned the entire earth from the high Himalayan peak on which he lived, Mt. Kailash, and chose Varanasi as the most beautiful place on earth, a place of streams, springs, dense forests on the edge of the Ganga, bejeweled with palaces, gardens, and temples. The mountain god, descended to Kashi became both a family man and a city man in the Forest of Bliss. It is now difficult to imagine the former great beauty of such a crowded city, but not very many centuries ago the land was full of pools and lakes through which pure water flowed. Temples and ashrams sat on the edges of lakes and streams in the forest in quiet seclusion.

Water is a central part of the collection of memories that is Kashi. The memory of water is deep, extending back to the origins of life itself. Dark water was present before the dawn of life on our planet, and today water provides a bridge to those beginnings. At dawn on the ghats of the Ganga as pilgrims dip into the Ganga, they move back in time, symbolically die to the world and then are reborn into the light of the rising sun which is itself reborn every morning. One of the greatest bathing festivals on the ghats is on the morning of new moon following Makara Samkranti, when the sun enters the constellation of Makaram, Sagittarius, which it once did on winter solstice, when the old year dies, and the new year is starting. On that morning, major primordial events are re-enacted: the birth of the moon, the birth of the year, and the birth of the day. The birth of life in the waters of the Ganga is celebrated in the river at the place where its waters are flowing northward to the place of the river's birth.

Beyond the river's edge, beyond the walls of buildings, beyond the narrow alleyways is a network pilgrimage paths, the yatras of Kashi, the sacred and cosmic realm of Varanasi. Therein lies a complex pilgrimage landscape established by the footprints of pilgrims, shrines, temples, and memory, with interlinking alignments in space and multi-layered structures of time (Singh 2002).

The Yatras of Varanasi

The *Padma Purana* (*Shristi Khanda*, 65.14-20), a 7th century text, describes the sacred territory of Kashi at the center of which lies at Madhyameshvara. Madhyameshvara refers to Lord Shiva around whom the universe revolves; Shiva keeps the universe alive and energized through his dance of destruction and creation; Madhya is the center and Ishvara is his name. The largest circumambulatory circuit covers 168 miles (296 km or 84 krosha) and is known as *Brihata Panchakroshi*, or *Chaurashikroshi Yatra.* Rarely performed now because of the lack of time of modern busy pilgrims, its exact route is not well known. In the past the journey was completed in 10 days, and it involved visiting 144 shrines.

During the past few centuries, this circuit has shrunk down to the present Panchakroshi and the three yatras that lie inside it. The Panchakroshi Yatra covers a distance of 5x5 *krosha* (*i.e.* 55.2 miles/88.6 km), requiring five nights and six days of walking and 108 shrines (this ubiquitous number has astronomical roots: 12 signs of the zodiac and 9 planets; or 4 cardinal directions, three realms of the cosmos and 9 planets; or 27 days of the lunar sidereal cycle and 4 directions). The circuit has two centers, the ancient center of Kashi at Madhyameshvara and the ritual center of Kashi at the Jnanavapi well where the initiation and concluding rites for most of the yatras take place (Singh 2002). The start of the pilgrimage starts with a ritual bath at Manikarnika ghat, the great cremation ghat of Varanasi, followed by a vow to complete the pilgrimage at the Jnanavapi well, the current center of the city. The first 17 shrines are along the banks of the Ganga. This is a landscape that is rich in memories, as many generations of Hindus have followed the same pathway, visited the same shrines, watched the same sun rising through the mists, and performed *darshan* to the same gods and goddesses.

Inside the Panchakroshi is the *Nagar Pradakshina*, covering 25 km and containing 72 shrines. The fourth level, *Avimukta*, also contains 72 shrines; the name *Avimukta* means the "Never Forsaken" zone, a place where Lord Shiva will never forsake, even a time of the dissolution of the cosmos. The journey to the "inner sanctum", the *Antargriha,* spirals seven times from Manikarnika

Devi into Vishveshvara and contains 72 shrines. Among its various meanings, the number seven refers to the seven realms of the heavens and the seven visible planets. Its presence in the inner sanctum of Kashi signifies the similarity of the macrocosm and microcosm.

These five sacred routes are identified with the five gross elements (sky, earth, air, water, and fire) and the five parts of the human body (head, legs, face, blood, and heart), affirming similarity of the macrocosm, the mesocosm of the sacred realm of Kashi, and the microcosm of the human body. (Singh 1993) By means of the simple act of walking through this space, the pilgrim participates in a non-verbal lesson about the symbolic structure of the cosmos and the connections between the divine and the human realms. Another pilgrimage route in Kashi incorporating cosmic symbolism is that of the 56 Vinayakas, which contains its seven spirals and eight directions of space. All of these are examples of self-similarity, which is an important characteristic of self-organized systems.

Self-Organization of Pilgrimage Landscapes

Pilgrimage landscapes contain the cumulative memories of generations of individuals who have moved across space in search of the sacred and holy. Similar to forest and ocean ecosystems, these landscapes can develop self-organized structures in space and time with repeating constellations of fractal patterns (Mandelbrot 1977) (Appendix). These patterns will emerge from a landscape only if it is open to new energies, has a unity built of multiple interconnections of interacting entities, and is not dominated by processes striving to maintain permanence and equilibrium (Malville 2001). Fractal patterns will not appear if there are too few individuals to achieve coherence and inter-connectedness. Non-interacting individuals arrive on a landscape like random strokes of lightning and contribute little to collective memory. Random events leave few memories; there is no memory in the toss of dice just as there is no memory in the imposed geometry of circle or square. All circles and squares are alike and in spite of their geometrical elegance they carry little information.

Between these extremes of randomness and perfect order lies of the realm of maximum embedded memory, which has also been described as “lying at the edge of chaos” (Kaufmann 1995) This is the region of snowflakes, complex forest ecosystems (Levin 1999), structures in the great herds of wildebeests in the Serengeti Plains, forest fires (Malamud, Morein, and Turcotte 1998), avalanches of sand and rice (Bak 1996), and fractals (Cambel 1993). Two important characteristics of self-organized patterns are self-similarity, wherein similar patterns are repeated at different sizes, and the presence of power law distributions of sizes of patterns. There are many more small self-organized patterns than large ones, and the very simple mathematical model of a power law can reproduce this behavior. The frequency of occurrence of a particular size decreases as a power of the size of the pattern or of the structures within it.

In real ecosystems, self-similarity and power law distributions are statistical; repeated structures are never exactly alike. An actual snowflake in the natural world with its approximate six-fold symmetry is never perfect. The structure of the snowflake reflects the variations of temperature, humidity, wind, and pressure as it moved through the atmosphere, and consequently no two snowflakes, while they may be statistically self-similar, will ever be exactly identical. For those who can read them, there is a vast amount of detailed information about atmospheric conditions that is obtainable from their broken symmetries.

The power law distribution is the fingerprint of self-organization that we can use in our search for the spontaneous patterns of nature, mature ecosystems, and other fractal landscapes (see Appendix). The sizes of fjords of Norway and other coastlines have well-established power law distributions (Mandelbrot 1977) as do features of forest communities (Levin and Buttrel 1997; Sole and Manrubia 1995), forest fires (Malamud, Morein, and Turcotte 1996), and even wars (Roberts and Turcotte 1998)

We first investigated the structure of shrines along the pilgrimage circuit of Mt. Kailash in Tibet, the most sacred mountain of south Asia by measuring the positions of the 54 major shines of

its kora with GPS. We found evidence for self-organization in the presence of a power law in the spacing of adjacent shrines. The frequency distribution of separation varies with a power of –1.5. We extended our measurements to the 108 shrines of the Panchakroshi yatra and found a similar distribution with a power of –1.4. Further measurements of all of the shrines along the four inner yatras of Varanasi, a total of 324 shrines, gave a distribution with a power of –1.5.

The recurrent power law in these two major pilgrimage circuits of Asia is a remarkable result. Although a power law is a necessary but not a sufficient condition for self-organization, these results do suggest pilgrimage landscapes can mimic the natural world. It provides a fascinating new perspective on an issue that has challenged philosophers for millennia (Prigogine 1997). The old dualistic concept of a fundamental difference between nature with its laws and humans with their creativity finds no support in these pilgrimage landscapes. When people become pilgrims and behave in a spontaneous manner as members of a self-interacting group, they become one with nature. In contrast, when a pilgrimage tradition is taken over by authority or rigid tradition, it loses its spontaneity and its characteristics of self-organization. There should be a full range of pilgrimage landscapes across the world, some self-organized and others with imposed structures, some remaining open to newness, spontaneity, and self-discovery, and others closed by rigid tradition.

Patterns in Time

When coherence and inter-connectedness prevail in an open system, small "disturbances" such as new ideas or new concentrations of people may not be locally contained or suppressed but may spread across the land. In such systems these of information, ideas, or people have no fundamental scale, which means that their sizes have a power law distribution. There is a new physics involved that is not taught in our introductory university courses: departures from equilibrium yield the most interesting forms of nature and fundamental particles no longer are the goal of all our searches. In a manner similar to the concept of emptiness in Buddhism, one searches but cannot find an absolute and fundamental scale that is the "building block" for all structures.

Forest fires are well-studied examples of pulses of energy in which, as we have already noted there is a power law distribution of sizes of fires (Malamud, Morein and Turcotte 1998). It is a small matter to extend the concept of pulses of forest fires to pilgrimage in which the "ignition" by an idea or motivation causes moving pulses of people, igniting multiple cascades of further pilgrims and even new types of pilgrimages.

The Ganetic basin and the whole of the sub-continent serve as the catchment basin for pilgrimage to Varanasi using the terminology of the Turners (Turner 1969; Turner and Turner 1978). If the catchment area functions as a self-organized landscape, pulses of people that move through the catchment basin on their way to Kashi should have distributions of sizes that also follow a power law. In order to test this proposal we recorded the hourly visitors to Asi Ghat over a period of 600 days between November 1999 and May 2001. All together, we have records of more than 1.3 million visitors.

Visitors to Asi Ghat arrive in great numbers at the time of festivals, and they also come every morning throughout the year (cf. Table 1). Festivals are established by the lunar-solar calendar, and we discovered a strong connectivity in time among the pilgrims. The following table gives the total numbers of visitors to Asi Ghat during major festivals of 1998, 1999, and 2000 and the specific festival of the lunar-solar calendar (Singh 1994). Note the small differences from one year to the next for specific festivals, which are most remarkable considering that people are coming from separate points of origin and from great distances. Consider, for example, the visitors during Shivaratri in the two years, 1999 and 2000, the numbers of which differed by only 1556 or 1.7%.

Table 1. Numbers of Visitors to Asi Ghat

	Festival	1999	2000	Change, %
1	Makara Samkranti January 14-15	37,802	45,293	19.8
2	Maha Shivaratri (Shiva's night)	14-Feb-99	4-Mar-00	
	Phalguna, K-13	21,712	23,268	7.2
3	Karttika Purnima	4-Nov-98	23-Nov-99	
	Kartikka, S-15	33,536	37,382	11.5
4	Margasira Purnima	3-Dec-98	22-Dec-99	
	Margashira, S-15	21,658	22,090	2.0
5	Surya Shasthi (Chhatha)		15-Nov-99	
	Karttika, S-7		38,265	
6	Magha/ Mauni Amavasya	17-Jan-99	5-Feb-00	
	Magha, K-15	10,344	10,569	2.2
7	Magha Purnima	31-Jan-99	19-Feb-00	
	Magha, S-15	5,809	5,246	- 9.7
8	Prabodhini Ekadashi	31-Oct-98	19-Nov-99	
	Karttika, S-11	9,292	8,649	- 6.9
9	Vasant Panchami	22-Jan-99	10-Feb-00	
	Magha, S-5	7,163	2,196	- 69.3

When we look at the numbers of hourly visitors to Asi Ghat we find that they fall into three major categories. (1) On those days, especially in the cool mornings of winter, when there are fewer than approximately 300 people arriving per hour, the system has not achieved self-organization and the pulses of visitors do not have a power law distribution. (2) When there are between approximately 300 and 2500 people per hour arriving at Asi Ghat, the system has achieved sufficient connectivity and mutual interactions that the system becomes self-organized. The sizes of pulses of people follow a power law with a power of –2.9. (3) At the times of major festivals when there are more than 2500 people arriving per hour, the system continues to be self-organized, but with a slightly different form. In this case the frequency of arrival of different sizes of groups has a power of –2.3. If people arrived entirely at random their numbers should follow a Poisson or an exponential function, which would be quite different from the power law distribution we have measured.

Concluding Remarks

These examples of power law distributions are consistent with pilgrimage as a coherent self-organized process. When pilgrims always walk across the land as members of a moving community they create enduring patterns, sometimes in parallel to the patterns of the sun and moon. The Turners speak of the *communitas* of pilgrimage (Turner and Turner 1978), and in many pilgrimage landscapes that community extends from earth to the heavens.

In the great trajectory of time that has swept through the universe since the onset of expansion some 15 billion years ago new patterns have emerged from the nearly infinite possibilities of Primordial Chaos. The future is a perpetual new construction, not a guaranteed product of deterministic laws.

In this study we have compared pilgrimage with biological and geological phenomena that similarly display self-organization. We believe, however, that the human processes that resulted in the placement of shrines and pulses of pilgrims are vastly more complex than the geophysical processes that generate fractal patterns in physical landscapes or even the intricate biological processes operating in complex ecosystems.

In self-organized pilgrimages, it is necessary that the system be open, that energy and ideas come and go, that individuals be spontaneous and free. In India, the scale of coherence and interaction is mind boggling in its vastness, extending across thousands of km of the sub-continent, involving the coherent behavior of millions of people who individually and collectively are seeking an experience of the holy and sacred. By the movement of their feet pilgrims provide maps and new meaning for an entire land.

APPENDIX

Fractals and Power Laws

Self-organization is characterized by a power law distribution of the sizes of its elements such the number of elements of a size r is given by

$$N = Ar^{-D}$$

where the power, D, may be defined as the fractal dimension .

Scale invariance or self-similarity is demonstrated by changing the scale of measurement from r to kr, where k is a scaling factor, as if one were to magnify or de-magnify an image. The image in its essence remains. The power law behavior remains unchanged and retains the same dimension:

$N = Ar^{-D}$ becomes $Ak^{-D}r^{-D}$

or simply

$$N = Br^{-D}.$$

We may test for scale invariance by means of log-log plots of geographic features and of time series.

Square or rectangular geometries with a dimension precisely equal to 2 are found in planned pre-conceived ritual landscapes such a royal city designed as the geometrically perfect "cosmic" cities of China or a Hindu temple built according to precise mathematical rules. With only a single dimension, these structures do not show power law distributions.

Table 2.

Pattern	**Dimension** (Cambel 1993)
Koch snowflake	1.262
Sierpinsky triangle	1.585
Atmospheric clouds	2.35
Woods Plants	1.28-1.79
Sea anemone	1.6
Coast lines	1.05-1.25
Turbulent flames	2.33
Pilgrimage circuits	*1.5*
Time Series: Forest Fires	1.3-1.5 (Malamud, Morein, Turcotte 1998)
Pilgrims to Asi Ghat	*2.3-2.9*

Scale invariance and self-similarity are fundamental characteristics of fractals. First introduced by Mandelbrot, fractals were so named because of their fractional dimensions, such as 1.6 for the sea anemone or 2.35 for clouds. Freedom from imposed dimensions of 1, 2 or 3 make fractals common features of the natural world. The real fractals found in nature are not geometrically precise or mathematically deterministic like the Mandelbrot set or other well-known fractals such as the Sierpinski triangle, or the von Koch snowflake (cf. Table 2). Like the actual snowflake with its damaged edges and broken symmetries, fractals of nature posses a statistical self-similarity in that patterns at different levels of scale are similar but never exactly duplicated.

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