CHAPTER III –

3 SUSTAINABLE BUILDING DESIGN PRINCIPLES (SBDP) AND THE FOURways HOUSE

Sub-problem 1 The first sub-problem is to define and discuss sustainable building design principles.

Hypotheses 1 The first hypothesis postulates that available information on sustainable building design does not address the specific needs of the FOURways house.

3.1 Defining sustainable building design principles

Four hundred years ago the French writer, Michel de Montaigne (1533-1592), warned us when he wrote, "Let us permit nature to have her way: she understands her business better than we do" (Hawkes 1996). In a world dominated by technology people no longer connect with nature as the source of their existence, instead they try to control and dominate her. World-wide environmental chaos is not surprising considering the lack of respect society has for nature, if we continue to destroy the planet at the same pace we will eradicate the source origin and basic survival. The implications of such a tragedy are too numerous to mention; hunger, lack of oxygen, polluted water, illness and ultimately death are only part of the scenario.

The Brundtland Report of 1988 contains the internationally accepted definition of sustainability, which reads as follows: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition falls short in terms of protecting the natural environment itself. A broader definition is more appropriate. D.L. Jones (1998:44) adapts the definition to read: "Development that meets the needs of the present and is at least as valuable to future generations as the value of the environmental exploitation that results".

The research into the definition of sustainability reveals that an even broader definition, which includes social and economic criteria as well as the environmental criteria, must be acknowledged as integral to achieve sustainable building design. This research will not discuss the economic aspects of sustainability. The social criteria are seen as inter-linked with the living environment and well-being and therefore are not dealt with separately.

Consider the meaning of the words "sustain" and "sustainable" as described in the Collins English Dictionary (1977:1034): "**sustain** (sus-tān') v.t. to keep from falling or sinking; to support or uphold; to nourish or keep alive; to endure or undergo; to withstand; to encourage... - **sustain'able** a. –...the act of sustaining; support". Also consider the Gaia principle defined by Doctor James Lovelock which: "proposes that all life on Earth has a symbiotic relationship with the planet....We are our environment (and vice versa) at a very fundamental level" (Baggs *et al* 1996:14). Combine these statements to conclude that if we do not sustain, nourish or uphold our planet we are killing our environment, and in so doing we are committing suicide.

Sustainable building design aims to assist the renewed relationship between people and the environment. A balanced design integrates the building ecosystem with the natural ecology; design through which nature and man are reunited (see Figure 3.1). A sustainable design has increased efficiency, fewer toxins, less pollution and healthier natural systems; it benefits rather than destroys the inhabitants' sense of well being.

"It will enhance the life of all species and, therefore, reduces fear or insecurity, and produces hope for the future. In a sustainable system, every element fulfils many different functions, and every function will be fulfilled by many elements. Thereby

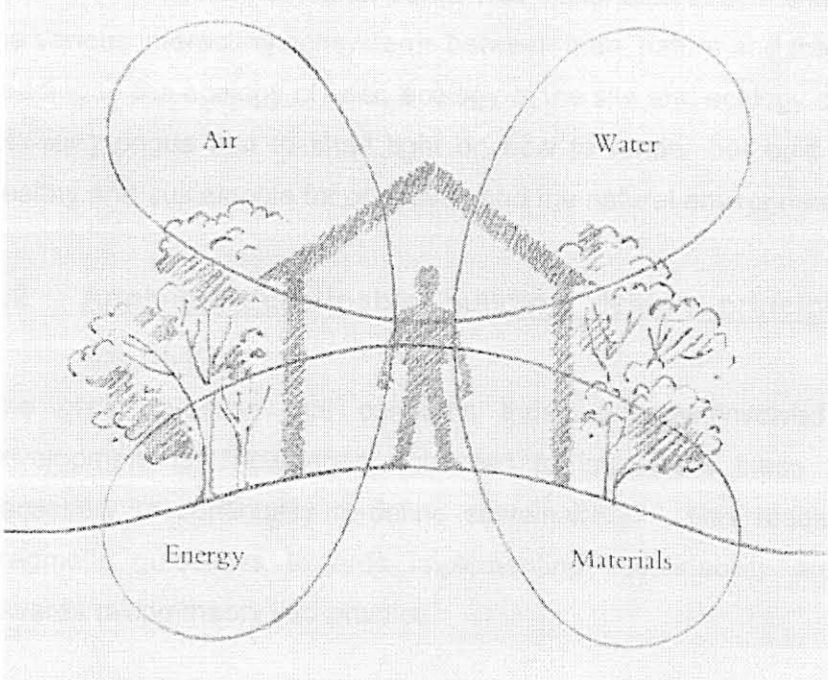


Figure 3.1 - The ecosystem of house and nature (Pearson 1989:25)

we will create the highest degree of flexibility and stability. As one element fails, others will be there to take over its function. Instead of maximising the function of single elements without the interrelationship to one another, we optimise the overall result by creating the largest number of useful links...in this system, people do not see themselves as masters of short term, exploitation of the earth, but as the custodians and stewards of a system which has come into being long before them and will operate long after them" (Kennedy 1992:47).

Natural forces like air circulation and natural heating together with building elements that are environmentally friendly are only some of the aspects of architecture that contribute to a sustainable building.

Well-being directly relates to health issues. To be healthy and have a sense of well-being one must live firstly in a healthy surrounding, that is a healthy home and surrounding environment. Secondly one's work place must also be a healthy environment. The workplace is outside the scope of this research, but the principles applied to a home also relevant here. Sound logic goes a long way to improve the quality of our living environment and eliminating illnesses relating to our modern lifestyle.

The movement Gaia promotes the house as a micro-ecosystem that interacts with the wider ecosystem of planet earth. This exploration of sustainability is divided into the various interacting ecosystems between man, nature and the building hence the headings - the ecology of user, ecology of the site and ecology of the building. The following pages aim to shed light on how to render our built environment more healthy and sustainable for ourselves and the natural environment.

3.2 <u>Applying sustainable building design principles in Gauteng (GSBDP)</u>

The great question that concerns those already involved with sustainable development is: "how does one start to implement these principles?" Is it necessary to continually re-define sustainability? This research proposes that pragmatic guidelines towards implementing sustainability are a relevant step towards taking theory into practice.

If we continue to destroy earth's non-renewable resources and accelerate the rate renewable resources are used; a lack of alternatives will force people to use ecological means like solar energy and wind power. It might be too late then to save us from self-destruction. People must be educated about the dangers immediately. Many people know the term "sick building syndrome"; few know what it truly means nor realise that it can be applied to their homes and not only their offices.

Five basic steps to move towards sustainable design were defined by Sim van der Ryn at the 1996 VIBA conference in the Netherlands. Table 3.1 discusses these five steps which are integrated with the Gaia principle where the house is a micro-ecosystem that interacts with the wider ecosystem of planet earth. The steps are commented on for their relevance to this study.

Table 3.1 - Five basic steps to move towards sustainable design

Sim van der Ryn:	Comment:
a) Solutions start with place (physical and cultural)	Gauteng, South Africa
b) Physiological accounting (ecological) = economic accounting	The benefits of environmental focus are automatically felt economically
c) Nature is the model for all design (bio-diversity) design with nature	The ecology of the building
d) We are designers and all users must be involved; by participating we become healed	Ecology of the user
e) Make nature visible	Ecology of the site

The environment consists of two aspects, human and biophysical. The built environment is composed of the human additions and alterations to the land surface. An urban area such as Gauteng is characterised by a built environment that dominates the natural environment. If development is continued with its characteristic modern disrespect for nature our planet will become exhausted.
A paradigm shift is required - a return to respect nature and her systems. Our habitation of earth should become a response to the natural environment.

There are two routes that reflect opposing philosophical attitudes to achieve sustainable housing developments, the "high tech approach" (see Figure 3.2) and the "permaculture approach" (see Figure 3.3). The "high-tech approach" believes that technological development can not be stopped in its course and therefore aims to optimise appropriate technology.

Jones (1998: 54) proposes that: "The channelling of scientific research and technological invention towards reducing material resource (and thus leading to energy conservation)". "For some salvation can only be met through a radical change in social and cultural values, with economic growth ceasing to be the panacea for prosperity and well-being, and with the family and community precedence over the individual. These people look to simple community-based lifestyles for their model, where materials and labour are obtained locally, and where everything that is taken from the world's limited supply of resources is returned, one way or another, in useful form" (Jones 1998: 11).

Possibly, the preferred route to building design and procurement is to find a balance between the two options. The application of sustainable building design principles can be applied from the outset of a project as a design philosophy or as retrofit. Retrofit is more costly, but the reality is that buildings already exist and many could provide healthier environments by applying sustainable building design principles.

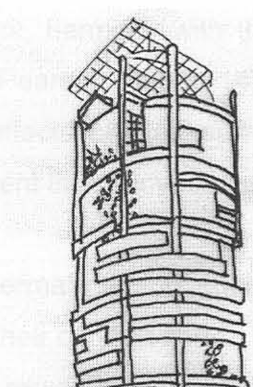


Figure 3.2 - The high tech approach to sustainable building design (illustration adapted from a K. Yeang design)

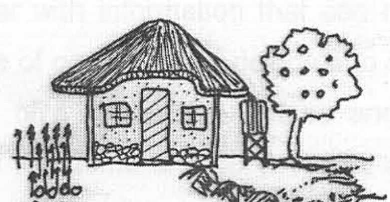


Figure 3.3 - The permaculture approach to sustainable building design (author's illustration)

3.3 Ecology of the user

Humans are a complex and diverse species and to define well-being for individuals is not the purpose of this study. The general range of phenomena that contribute to a sense of well-being will be used to establish what can be considered a healthy environment that enhances a sense of well-being.

Air, light, water, food, warmth, food, clothing and shelter are basic human needs that are derived directly and indirectly from the environment. The first humans depended on essentials for survival, but through the centuries humans have developed the desire for 'more'. Food varieties, different forms of shelter determined by style, a greater choice of clothing and as the world modernises rapidly our demands get more elaborate - we have moved a far way from basic survival to a culture of 'greed' rather than 'need'.

The user educated in the benefits of applying sustainable building design principles will make the choice and ultimate purchase of a house in a different way to a purely economic standpoint. The number and type of rooms, lifestyle and aesthetic style still play a role, but the list of requirements will have changed. A new understanding of the relationship between the inhabitants and their lifestyle in relation to the environment on a local and broader scale should be the root of a new set of requirements. Users will increasingly become aware of the influence their surroundings has on their physical and mental well being. "Health for the body, peace for the spirit, harmony with the environment - these are the criteria of the natural house" (Pearson 1989: 14). The inhabitants should be educated to understand the effects of their surroundings in order that they can protect and improve their current living environment to a pollution free, healthy environment.

Understanding thermal comfort equips the user with information that can help to actively regulate their comfort zone. Knowledge of passive solar design and natural air circulation to regulate the generic climate of a space can reduce and even eliminate the use of artificial climate control in the home and so doing be energy efficient. When the design is initially set out the designers should interact with the buyer to ensure the layout complements the lifestyle and natural surrounding environment. The designer should facilitate the initial interaction between the home owner, the home and the environment.

A comfort zone is the average definition of comfort for a group of people; rather, the absence of discomfort incorporates a larger group of individuals that define comfort differently. The absence of discomfort means to remove all materials and systems that adversely affect the health and to allow for individual adjustment to internal climatic conditions.

The physiological requirements of users

The building must be designed to meet the use requirements set by human needs. Beyond spaces required for specific activities the building should provide for human well-being as well. Well-being is when a person has optimal health and a happy disposition. A healthy body and good physiological state leads to productivity and consequently prosperity. The built environment should promote well-being by providing shelter that is a healthy surround with thermal comfort. Air that is not polluted and will not affect ones health adversely, sound levels that do not damage hearing or could be considered disturbing, internal climate that is comfortable and thereby supports both activity and rest.

Mechanical equipment can artificially provide the "ideal" environment for living in, with air conditioning, humidifiers, ionisers etc. This approach is costly in terms of purchasing and running the equipment and has negative effects on the existing natural surroundings. There are many alternatives to provide a shelter that fosters well-being without the use mechanical equipment. Environmentally conscious building design meets human needs and avoids a destructive impact on the environment.

3.4 Ecology of the site

Ideally a healthy home is built of sustainable materials in an area that is conducive to well being. Unfortunately such an ideal is largely unattainable and compromise is necessary. The goal is to deliver the best possible living environment within a given location for a fixed budget. To achieve the goal of sustainable living environments there are several principles that if adhered to will produce a house and environment that act as an integrated ecosystem.

The movement Gaia promotes the house as a micro-ecosystem that interacts with the wider ecosystem of planet earth. The site is the first interface between the building, its occupants and the environment. Site investigation is the first step to understanding the environment of the building.

The earth and her ecosystems have been functioning for thousands of years, even before the event of human beings. The earth has witnessed the modification of many ecosystems since the first humans inhabited her, essentially the continual changing renders the planet earth no longer "original", such is the essence of evolution. Jones (1998:63) suggests that we can assume that whether a site is located in an urban area or rural setting it remains equally artificial or unnatural, the only difference is that the city is dominated by buildings (see Figure 3.4) and the countryside by vegetation (see Figure 3.5). An environmentally aware design will generate a building that is anchored to its surroundings by its physical and cultural context.

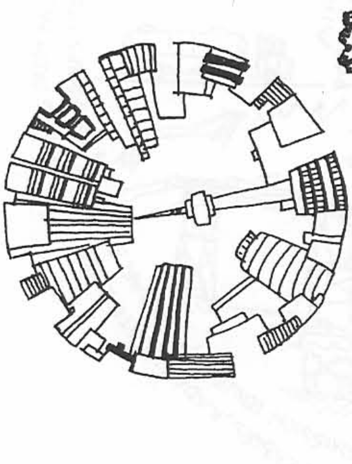


Figure 3.4 - The city (inner city and suburbs) dominated by buildings (author's illustration)

Figure 3.5 - The countryside (farming area and natural reserves) dominated by vegetation (author's illustration)

3.4.1 Location

When selecting a site consider the surroundings as part of the whole building design. To understand the nature of the environment of the building it is necessary to assess the site and the surrounding area. Figure 3.6 illustrates the factors important to a site location. A sustainable building must respond to the immediate and broader surrounding. Proximity to air, noise, ground and electro-pollution negatively affect both our senses and physical well being and should therefore be avoided when possible. Alleviated negative effects by considering the orientating away from the problem and choosing materials and construction methods that do not add to the problem with toxic emissions and the like. Rather mitigate the negative effects through harnessing benefits such as acoustic absorption, air and water filtration and so on.

The area must display a balanced of mixed use areas with public and private, open spaces and built forms, young and old, schools, shopping centres, recreation areas, playgrounds and homes all within walking distance. Diversity ensures a better social structure and avoids the formation of ghettos.

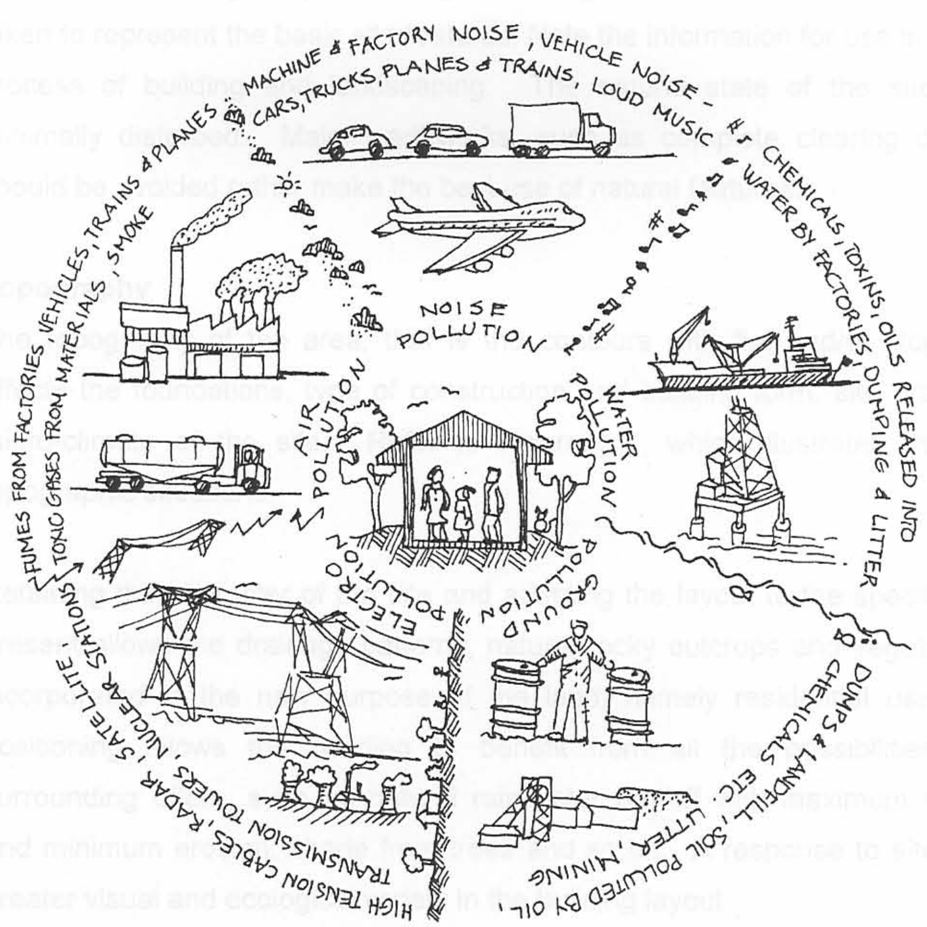


Figure 3.6 - Factors important to a site location (author's illustration)

The interest in local climate, light and topography are not restricted to the movement 'critical regionalism'. Local climate, light and topography are part of our response to understand the character of the natural environment that forms the specific site. The existing flora and fauna, cultural heritage, topography and climate of the site all influence the planning of a building that responds appropriately to its location.

3.4.2 Site features and natural environment

Assess the condition of the natural state of the site and the immediate environment, flora, fauna and topography including the soil condition and ground water to determine if the site can be developed in a sustainable way, where the ecology of the site and the building ecosystem form and integrated whole. Identify the broad geology and vegetation type of the location. Identify the soil type, rocks, fall of the site, drainage patterns and natural surface water on the site. In the case of a mechanically cleared site where no specific evidence remains of the broader information about geology and vegetation together with the soil analysis will be taken to represent the basic site features. Note the information for use in the design process of building and landscaping. The natural state of the site must be minimally disturbed. Major earthworks, such as complete clearing of the site, should be avoided rather make the best use of natural features.

Topography

The topography of the area, that is the contours with flat and/or sloped areas, affects the foundations, type of construction and building form, site drainage and micro-climate of the site. Refer to Figure 3.7, which illustrates the different topographic situations.

Retaining the character of the site and adapting the layout to the specific features present allows the drainage patterns, natural rocky outcrops and vegetation to be incorporated in the new purpose of the land, namely residential use. Correct positioning allows the building to benefit from all the possibilities that the surrounding offers, such as natural rain-water run-off with maximum penetration and minimum erosion, shade from trees and so on. A response to site results in greater visual and ecological variety in the building layout.

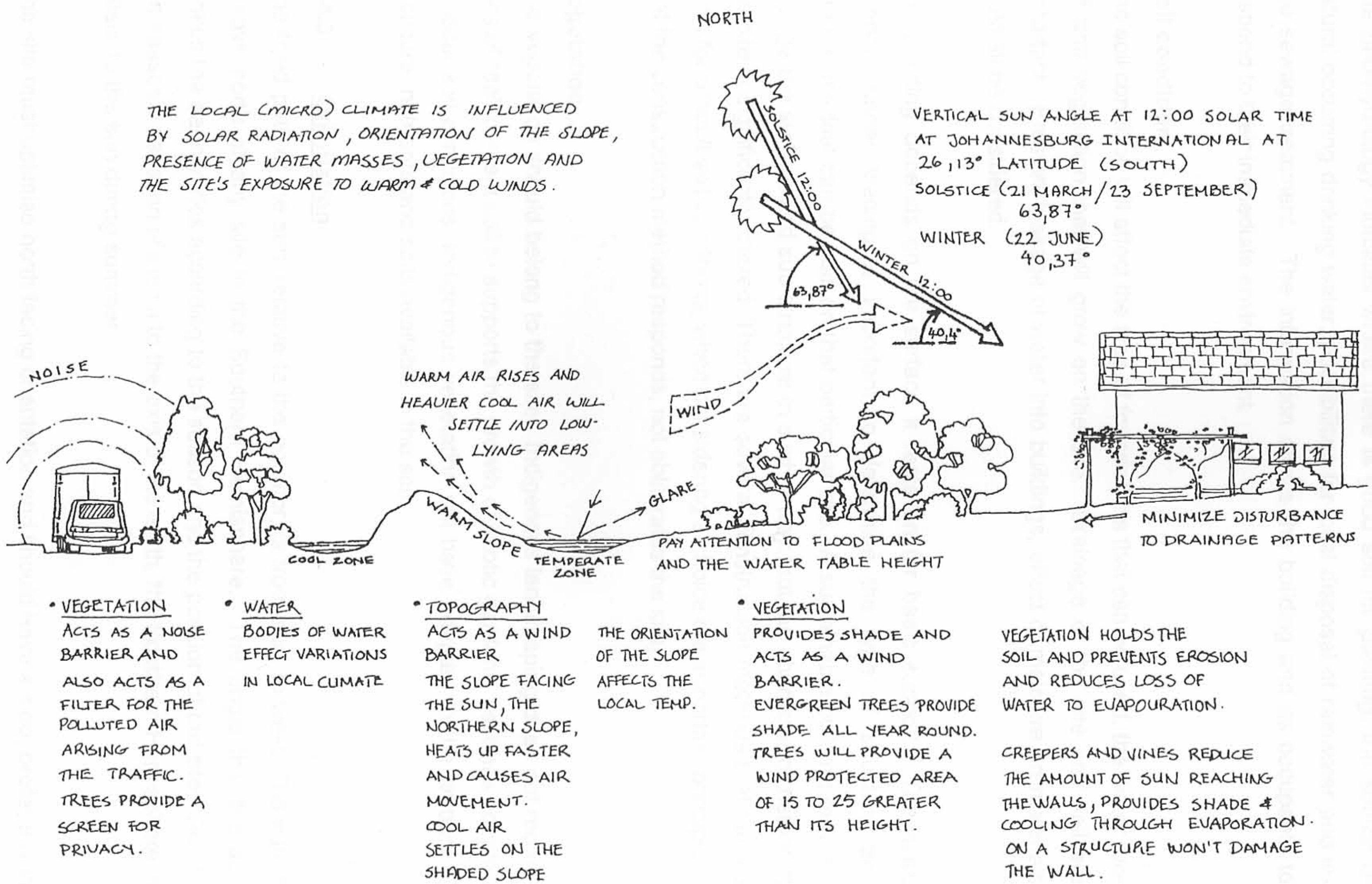


Figure 3.7 - The effect of the topography of a flat site and a sloped site (author's illustration)

The geo-hydrology indicates where there is good soil for planting, the source of natural occurring drinking water, possibilities for local disposal of rainwater and in-situ sewage treatment. The information allows the building and its occupants to respond to their immediate environment.

Soil condition

The soil condition will affect the type of foundations that can be used, the water run-off and vegetation that will grow on the site. Drainage of the site and soil are important. Erosion, leakage of water into buildings, effect of moisture on materials must all be considered.

The building depends on the surface it rests on for basic support. The soil's strength under loading is important to determine the type of structure and foundations that can be built on that particular site. A sustainable building may not change the surface and sub-structure in such a way that the character or nature of the site is significantly altered. There are several construction methods that can be used for difficult soil conditions, when considering a choice the important principle is that the construction method responds, not obliterates the site.

Vegetation

The vegetation should belong to the site. Indigenous landscaping does not require tons of replacement soil to supports the growth of exotic gardens, as it has adapted to local soil conditions. Indigenous vegetation will have adapted to the amount of moisture, nutrients and salts available in the soil.

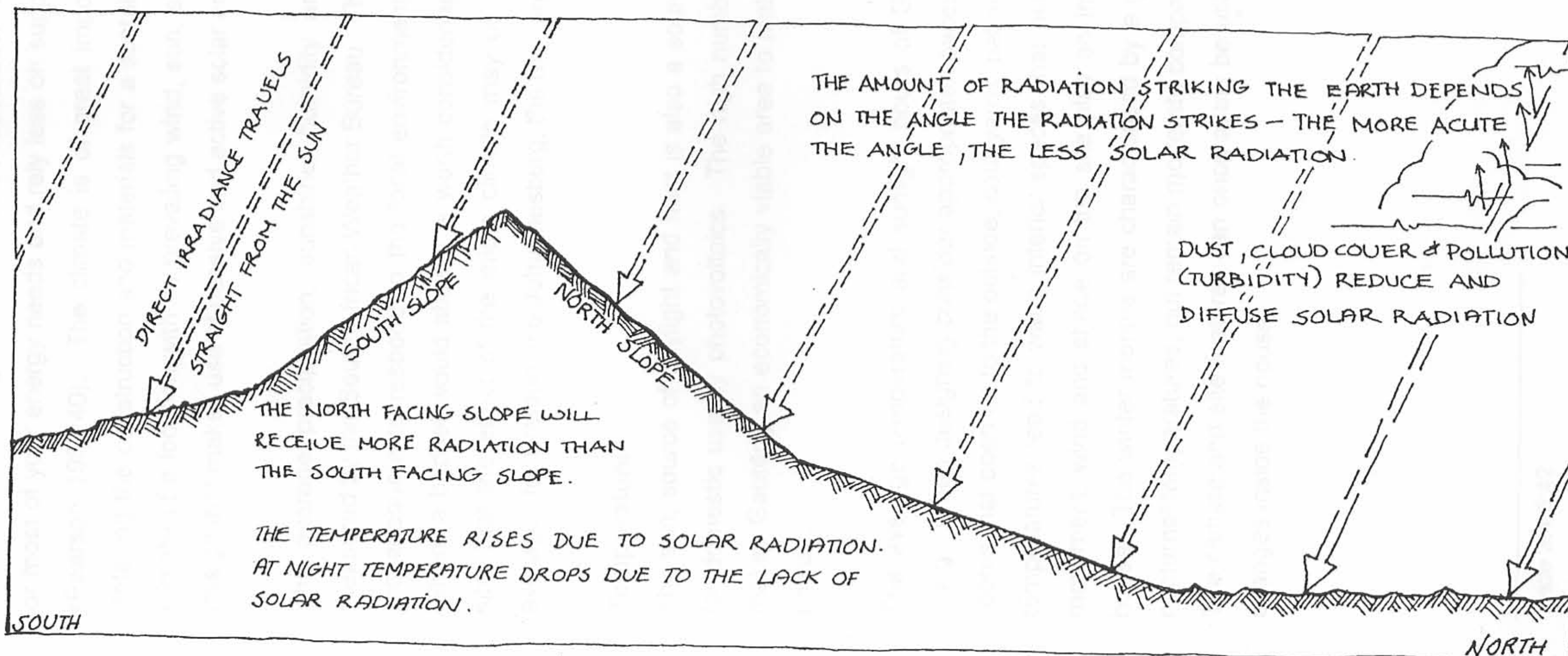
3.4.3 Orientation

The fixed path of the sun, relative to the equator, is from east to west. The sun is always north of any site in the Southern Hemisphere. The angle that the sun strikes the earth varies according to the season and the position of the site. Due to the seasonal variation of the tilt to the axis of the earth, the Southern Hemisphere is closer to the sun during summer.

The site must optimise north facing orientation and should have a side, preferably in the length, longest axis running east-west, to facilitate the maximum opportunities to design a north facing building. The optimal siting of a building will influence the opportunities for sustainability such as daylight, ventilation and heating etc.

The type of view will also influence the orientation of the building on the site. Preferably, a home would not directly view industry, high-tension pylons, highways and other man-made constructions, yet these are real objects in the landscape of the location. There are various means of dealing with problems of view such as vegetation, landscaping, and treatment of openings. The view is closely linked to the spiritual content of the building therefore further discussion is outside the scope of this research.

*IRRADIANCE IS THE AMOUNT AND RATE OF SOLAR RADIATION MEASURED ON A UNIT AREA AS WATTS PER METRE SQUARED. SOLAR RADIATION IS RECEIVED ON THE GROUND ACROSS A RANGE OF FREQUENCIES, FROM INFRA-RED THROUGH THE VISIBLE SPECTRUM TO ULTRA-VIOLET. (HOLM & VILJOEN 1996: 4)



RAINFALL – THE WINDWARD SIDE OF A MOUNTAIN WILL BE EXPOSED TO THE FULL FORCE OF THE RAINFALL AND THEREFORE MORE RAIN FALLS ON THE WINDWARD SIDE

Figure 3.8 - The effect of orientation on a flat site and a sloped site (adapted from Holm & Viljoen 1996)

3.4.4 Climate

One of the principles promoted by Gaia is: "site, orient and shelter the home to make best and conserving use of renewable resources. Use the sun, wind, and water for all or most of your energy needs and rely less on supplementary, non-renewable energy" (Pearson 1989:40). The climate is of great importance when locating, orientating, detailing the construction and materials for a sustainable building. Understanding the climate of a location with its prevailing wind, sun, shading and precipitation allows for design that makes use of passive and active solar energy and natural ventilation.

The average precipitation, sunshine, humidity and temperatures in Gauteng are measured by the South African Weather Bureau. The averages calculated for the area are adequate to respond to the local environment of a site in an appropriate way. Where a budget would allow it is worth considering specific measurements taken on site, that the effect of the micro climate may be determined. Table 3.2 gives the averages for Pretoria and Johannesburg, the two largest cities in the province.

Temperature

The sun, source of daylight and heat is also a source of electrical power transformed for domestic use by photovoltaics. The high number of sunlight hours and radiation makes Gauteng an economically viable area to make use of active and passive solar power[1].

The average temperature and sunlight hours of Gauteng are conducive to outdoor living. When designing consider appropriate spaces to living both inside and outside, rooms that open up to the outside, courtyards, patios and pergolas. The warm summer temperatures lead to warm interior spaces that need to be cooled. The natural air movement, wind and shade on the site play an important role in the design of the house. The winter months are characterised by a great difference in the diurnal and nocturnal temperatures, but remain moderate compared to other areas in South Africa. The climate and site features can once again be utilised to moderate the temperature changes inside the house.

---

[1] *vide* 3.4.5:42

Table 3.2 - The average climatic data for Johannesburg and Pretoria (adapted from the directorate climatology of the South African Weather Bureau 2000)

STATISTIC	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
Average daily number of sunshine hours	8,1	8,0	7,7	7,9	8,9	8,9	9,2	9,2	9,4	8,7	8,3	8,5	7,8
Average rainfall in millimetres for Johannesburg	125	90	91	54	13	9	4	6	27	72	117	105	619 annual
Average rainfall in millimetres for Pretoria	136	75	82	51	13	7	3	6	22	71	98	110	674 annual
Average maximum temperatures in degrees Celsius for Johannesburg	25,6	25,1	24,0	21,1	18,9	16,0	16,7	19,4	22,8	23,8	24,2	25,2	20,5
Average maximum temperatures in degrees Celsius for Pretoria	28,6	28,0	27,0	24,1	21,9	19,1	19,6	22,2	25,5	26,6	27,1	28,0	23,1
Average minimum temperatures in degrees Celsius for Johannesburg	14,7	14,1	13,1	10,3	7,2	4,1	4,1	6,2	9,3	11,2	12,7	13,9	10,0
Average minimum temperatures in degrees Celsius for Pretoria	17,5	17,2	16,0	12,2	7,8	4,5	4,5	7,6	11,7	14,2	15,7	16,8	12,4
Average minimum humidity (%)	24	25	27	22	19	16	13	10	10	12	19	23	18,3
Average maximum humidity (%)	97	96	96	97	97	97	97	97	96	97	97	97	96,7

Rainfall

The characteristic short but heavy thunderstorms requires careful planing around the natural drainage patterns of the site and house design.

Humidity

Humidity is the moisture content of the air, expressed as a percentage of the total capacity of moisture air can contain. A high humidity is experiences as warmer than a lower humidity at the same temperature.

The humidity of Gauteng can be relatively high but does not often reach uncomfortable levels in comparison to coastal areas. The dry winter weather is experienced as a greater problem for many people. Vegetation and surface water on the site can help to alleviate the low humidity in winter.

Wind

Summer winds in Gauteng are predominately north-easterly, and winter winds are predominantly north-westerly, but there is also a fair amount of south-westerly wind. (Holm 1996:64 [see Appendix 2]).

Wind is a natural resource that can assist ventilation of a building and by mechanical means be harvested to generate power (see Figure 3.9). The construction and thermal dynamics of the building are also influenced by the wind. The strength of the wind is not substantial enough to influence the construction of buildings in Gauteng, but should be used as a passive climate control.

Figure 3.9 – The harnessing of wind energy (Pearson 1989:79)

3.4.5 Energy

The Gaia house charter states that in order to design in harmony with the planet we should: "design the house to be 'intelligent' in its use of resources and complement natural mechanisms, if necessary with efficient control systems to regulate energy, heating, cooling, water, airflow and lighting" (Pearson 1989:40).

The term energy includes a broad range of visible energy, which includes electricity that is common to urban residences and the non-visible in the form of the natural energy fields of the earth itself. Natural sources of energy such as the sun, wind and water can be harnessed in the urban setting and are not limited to experimental use in grand scale developments. Energy conscious design avoids becoming completely dependant on the main electrical supply grid. The passive energy source from the sun and wind are viable alternatives making cost-effective use of natural renewable resources.

In South Africa conventional supply grid electricity is supplied by Eskom. Hot water and lighting are generally powered by commercial power supply. The orientation of a site that maximum use may be made of both passive and active solar energy is a priority for a sustainable solution. The use of solar panels and photovoltaic cells to generate heat and power is possible with the average of eight and a half sunlight hours per day in Gauteng.

There is not enough wind in Gauteng to generate energy but it can be used in the passive form of natural ventilation.

Geopathic stress – Natural earth energy

Check the site for electro-pollution; also know as geopathic stress. The general term geopathic stress refers to the discomfort and illness that occurs when the earth's natural magnetic field (the magnetic poles) is disturbed by natural or man-made energy fields. "Geopathic stress is an insidious phenomenon: we cannot see it or adequately explain it in current scientific terms, but the effects of it are likely to prove at least as devastating as environmental pollution" (Thurnell-Read 1995:xi). Dowsing, the alternate method to scientific measurement has proved unreliable due to charlatan practitioners. Currently the best advice is to look at signs on the natural environment of the site.

Disturbances to the earth's magnetic field include geological faults, underground ore masses, underground water especially running water and man-made disturbances include mining, deep foundations, sewerage pipes, high-tension power lines and other services. Geological energies have always been present but due to the technological advancement humans have become more exposed and therefore susceptible to the disturbances of the ever present back-ground energy field of the earth's magnetic poles (*ibid*: 1-13).

A visual analysis of the site can reveal possible energy field disturbances. The proximity of ground water to the site, surface water is not problematic. Trees often reveal if there is a disturbance as they grow unconventionally, they display gnarled or distorted growth patterns. Tietze (1988) is quoted in the book, '*The healthy house*' (Baggs *et al* 1996: 42): "Dogs, pigs and other animals are said to avoid areas where subterranean water veins intersect. Trees will branch down towards radiation and ants will nests above radiation lines. Bees are said to produce more honey when their nests are built over such zones. Wasps tend towards zones of radiation and cats prefer to rest over them". Check the area for high-tension power lines running close to or crossing the site, radar and satellite dishes, transmission towers and nuclear stations in the surrounding area. It is worthwhile to check whether any underground tunnels cross the site as Gauteng has experienced a large amount of mining activity. (see Figure 3.6)

Geopathic stresses are important to the well-being of inhabitants and should form part of the original analysis that determines whether a site is appropriate for development.

3.4.6 <u>Water</u>

Water is a renewable resource but through an ever increasing demand and wastage has become a precious resource not to be squandered.

Ground water

Ground water generally provides a purer water supply on site than municipal water supply that is chemically treated. This requires an investment to assess if water is on site and whether the water table is constant and is an adequate supply. The water table should not drop significantly due to extraction of ground water and the source must be tested for possible ground pollution. If the conditions are right a bore-hole and pump will be required to bring the water to the surface. The initial costs are higher than linking to the municipal supply, however if this is a resource shared by a number of houses in a complex the long-term benefits outweigh costs.

Rainwater

Harvest rainwater from roofs to use for garden irrigation and toilet flushing. Encourage rainfall run-off through planned maximum water penetration. Eliminate erosion by designing to allow for water to penetration soil on roads and driveways of that are paved and facilitate the water to seep between rather than run over an impenetrable surface like tar.

Gardens and water

Sustainable gardens are "water-wise", requiring minimum supplementary irrigation[2]. Water the garden in the early morning or evening, as not to loose water to the heat of the day. Vegetation and mulch in the garden beds prevent moisture loss to evaporation and run-off.

Surface water

Surface water is found on site in the form of natural pools, river or streams or a built pond on site. The presence and extent of surface water on the site creates a natural cooling system through evaporation and air movement as well as visual variety. The temperature difference between the water and ground mass causes air movement from the cooler to the warmer mass. During the day the water heats up faster than the land mass and air moves from the cooler ground mass to the water surface. At night the earth mass radiate the heat it has retained during the day and the air movement is reversed. Careful placing of a water area in relation to the building allows for cool breezes to cool the building during the warmer summer days, and to provide air moisture during the dry winter days. (see Figure 3.7)

3.4.7 <u>Waste</u>

The site must be checked for pollution of old rubble from previous buildings or dumping. Pollutants such as plastic containers, tins, household waste and non-biodegradable materials do not form part of a natural condition.

Soil displaced for construction should be re-used on site. Demolishment rubble on site should be sorted and re-used if possible or disposed of according to the rubble type. Where vegetation is to be cleared re-use wood and organic waste for starting the composting system. Medium density developments provide the opportunity to centralise waste disposal into re-cycleable categories. Not only household waste but also, organic waste from the gardens can be used to make compost that can be re-cycled for the garden.

[2] *vide* 3.4.8:46

3.4.8 Fauna and Flora

The Gaia house charter states that in order to design in harmony with the planet we should: "Integrate the house with the local eco-system, by planting indigenous tree and flower species. Compost organic wastes, garden organically, and use natural pest control- no pesticides." (Pearson 1989:40)

The flora and fauna of a site contribute to the aesthetic appeal and climate of the area. A beautiful natural setting has been proved to aid healing and support a sense of well-being. Vegetation acts as a pollution filter, noise buffer, creates privacy and provides relief from the built environment. Therefore, the ratio of site to building should allow for adequate garden space. A green road edge gives the impression of open space with consequent benefits and each garden can provide a diversity of flora and fauna in the area.

A sustainable garden conserves water, protects the environment and provides a natural haven around the house. Vegetation stabilises soil; the roots that hold the soil and provide a cover over the soil prevent erosion. The root systems of the plants increase the permeability of the soil for rainwater and air. There are many benefits to retain and plant an indigenous garden.

Indigenous plants

Indigenous gardens grow fast and well in the specific climate of the location they are adapted to. Plant loss is reduced, less supplementary irrigation than exotic gardens is required thereby alleviating the pressure on the water supply, and the indigenous garden is a host to the natural wildlife in of the area.

Planning the landscape

When landscaping plan the variety of plants to create external conditions that complement living both in and outdoors. Ching (1975:1.6-1.7) advises when selecting trees in landscaping that the overall form, density and colour of the foliage, height and spread of the trees, speed and rate of growth, size and depth of root structure, soil, water, sunlight, air temperature requirements are considered relative to the site and building.

Vegetation tempering climatic variations

Appropriate landscaping creates external conditions that complement the building and can aid in conserving energy. Plants by their natural systems of absorption and evaporation have a cooling effect. Landscaping can reduce the direct sun reaching the house facades preventing heat being transferred to the house. Depending on the position, density of foliage, size and shape of the trees they provide shade to the building. Deciduous trees shade in the summer and in winter when they loose their leaves they allow the sun to reach the surfaces of the house to provide extra warmth. Evergreen trees can provide permanent shading from the sharp west light of the setting sun. (see Figure 3.7)

Vines and creepers are effective shading devices, preventing the heat of the sun from reaching the wall mass. Trellises placed close to walls can provide support without any damage occurring to the walls. Evergreen plants can be used to shade in the summer and insulate in the winter. (see Figure 3.7)

Groundcover and vegetation can act as a reflective surface. They do not absorb heat like asphalt. They reduce the ambient temperature around the building. Groundcover, vegetation and mulch prevent excessive evaporation of ground water. (see Figure 3.7)

Trees and planting can also affect the wind, reducing the wind velocity where required by being placed as a wind block or to channel cool breezes into and around the house. (see Figure 3.8) The effective zone of protection for a windbreak can be thirty times the height of the trees. The maximum protection occurs within five to seven times the tree height. For example, if the windbreak is 5 metres tall, it should be placed from 25 to 35 metres from the house (Sustainable Building Sourcebook 1998). The amount of foliage, shape and size affects the potential for a tree to act as a wind break. Evergreen trees are effective as windbreaks all year round. Consider the position of the tree relative to the building, if planted too close to a building the roots of trees may damage or disrupt the foundations and plumbing lines.

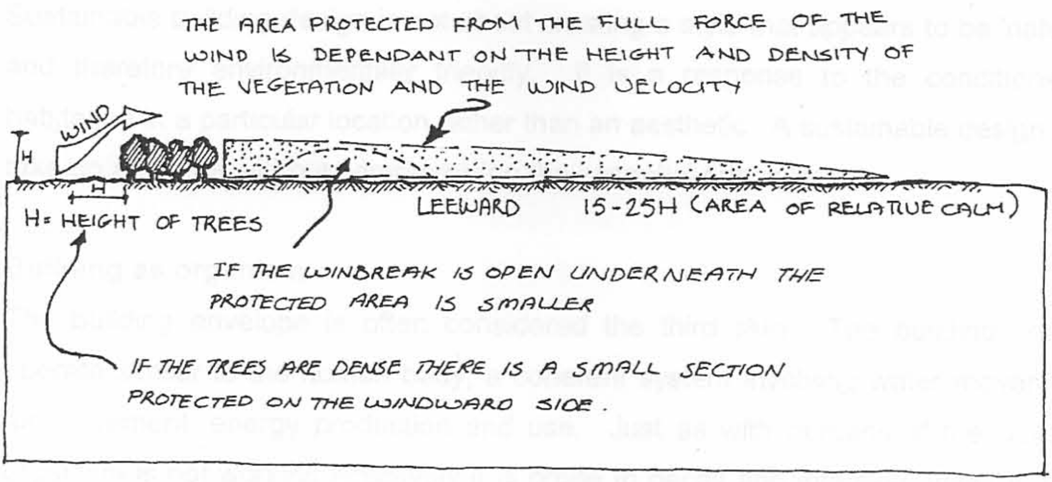


Figure 3.10 – The effect of trees on the micro climate (adapted from Ching 1975)

Pollution filters

The garden can alleviate a certain amount, though not all air and noise pollution. Vegetation filters the air and wind-blown dust in the immediate environment of the garden and home. The developed garden with its height and foliage density also forms a perceived barrier for noise. (see Figure 3.7)

Though not researched, it is believed by some that the natural vibrations (energy)of a garden can also alleviate electro-pollution. The gnarled trees in an area with geopathic stress illustrate the potential of vegetation to respond to electro-pollution. The extent to which the garden improves a situation is unknown.

Food production

Dedicating a section of the garden for growing provides a valuable fresh recourse of food. This not only provides a source of fresh seasonal fruit and vegetables but also food free of insecticides and toxins. In a permaculture the food production is one of the essential components of the system.