

SCISCITATOR – 2015

The Official Magazine of YRF

2015/Volume 02



Young Researchers' Forum
Postgraduate Institute of Science
University of Peradeniya
Peradeniya
Sri Lanka

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The Official Magazine of YRF
Sciscitator – 2015/Volume 02
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Young Researchers' Forum

Young Researchers' Forum (YRF) is the official consortium of the researchers registered for the postgraduate studies at the Postgraduate Institute of Science (PGIS), University of Peradeniya. The forum consists of full-time and part-time researchers who carry out research in various fields to contribute to the empowerment of the empirical and theoretical research in Sri Lanka and thereby foster the development of the country. Currently the YRF members are involved in research dealing with the disciplines of Chemical Sciences, Geological Sciences, Computer Sciences, Plant Sciences, Environmental Sciences, Biochemical Sciences, Mathematical Sciences and other multidisciplinary areas.

The forum was established in 2005 at the seminar themed "Challenges and Opportunities in Scientific Research for Young Researchers" aimed to bring up the young researchers to a collaboration where all the young researchers share their experience and knowledge to a common goal of enlightening the future of researchers who are at the early stage of their career.

Hence, the elite prime vision of the YRF is to

- Realize the potential of young researchers as the next generation of scientists
- Interact and exchange information pertaining to scientific research in order to disseminate knowledge and extend collaboration among different groups (local and foreign) of similar interests
- Generate a research climate that allows for creativity, open communication and free flow of ideas and talents
- Create a platform to bring the attention of the authorities and government, the problem faced by young researchers in carrying out scientific research in Sri Lanka
- Promote public awareness and importance of scientific research

As for now, YRF is being the voice of young researchers as well as the strength of postgraduate students at the University of Peradeniya. Pre-eminent commitment of all the committee members previous and current, indefatigable guidance of the staff members and invaluable support of the YRF members have paid off with a well-established forum to the dignity. The forum never hesitates to express their gratitude to everyone who contributed for the journey so far.

YRF welcomes all the postgraduate students (Ph.D., M.Phil. and M.Sc.) registered at the Postgraduate Institute of Science to come and join with us to make a noble impact to the research culture in Sri Lanka.

YRF President's Message

When I look at YRF, I see a balanced body made up of what I believe to be the best group of researchers with many potentials. I see individuals who, not content to rest on past accomplishments, constantly challenged themselves and their colleagues to find innovative ways to create value and provide the highest level of service to the society.

YRF continually strive to attract young researchers to the forum. As they are the most valuable assets of this forum, they are treated with respect, courtesy and fairness.

YRF is committed to maintain the standards of the research and achievements. With the best practices of the forum and continuous guidance of the staff YRF continually strive to be the premier students' body in Postgraduate Institute of Science.

Sciscitator is our communication media to disseminate knowledge. We bring scientific knowledge in a simplest way to intrigue the public about scientific facts.

YRF understands its duty to strive in research and its responsibility to contribute to the society. As a students' forum YRF is willing to bring prestige to the PGIS and to the university.

Sarath Kumara
President, Young Researchers' Forum
Postgraduate Institute of Science

Message from the Director, Postgraduate Institute of Science

It is with great pleasure that I provide this message to mark the release of the second issue of Sciscitator, the official magazine of the Young Researchers' Forum (YRF) of the Postgraduate Institute of Science (PGIS), University of Peradeniya.

Any postgraduate student conducting research as a registered student of the PGIS is eligible to be a member of the YRF. The members of the YRF, with the leadership of its President, have taken various measures for the development of science, and to strengthen the research culture of the PGIS. Activities, such as popular lectures by researchers, and workshops on the improvement of soft skills and social activities, organized by the YRF, have provided effective means to improve interaction between YRF members and scientific community.

Conduct of research is the key to the success of industrial development, and consequently the development of a nation. Dissemination of knowledge, an integral part of research, is thus become very valuable. The YRF, in this context, has taken the initiative to continue its annual magazine, Sciscitator. I am glad to see that students of many Boards of Study of the PGIS have contributed to this magazine by providing scientific articles. I congratulate the YRF for its great effort in publishing Sciscitator.

I have no doubt that the YRF would continue to expand improving its activities to shine it across the nation. I wish the YRF a great success!

Prof. H.M.D. Namal Priyantha
Director, Postgraduate Institute of Science
University of Peradeniya

Message from the Chief Editor of Sciscitator

I am very pleased to see that the research students of the Postgraduate Institute of Science (PGIS), University of Peradeniya, are launching their second issue of the Sciscitator magazine today. Researchers enrolled for postgraduate degrees are immensely contributed to develop the research culture at the PGIS. In addition, dissemination of knowledge generated through their research assists in various ways for the development of the country. Therefore, it is very important to publish the results of their research activities as it also helps to get international recognition to the PGIS and the country. This magazine opens up new opportunities for the members of the YRF to share scientific knowledge.

This issue consists of 25 articles written by postgraduate students who research in many scientific disciplines. I would like to thank the authors for coming forward to publish their articles in “Sciscitator” making it a success. I congratulate all authors for their hard work, commitment and untiring efforts of the members. I also thanks the members of the YRF for bringing up the YRF better and better every day. I have no doubt that the YRF would continue to grow, and hope that the YRF will be evolved in the future to bring the international recognition to the YRF and the PGIS. I wish the Young Researchers’ Forum all the success.

Prof. S. R. Kodituwakku,
Head/ Department of Statistics and Computer Science, University of Peradeniya
Director /IT Center, University of Peradeniya
Chairman/ BoS in Statistics and Computer Science, PGIS

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PLANT SCIENCES AND FORESTRY

A BRIEF OVERVIEW OF IMPACTS OF RIVER REGULATION ON RIVERINE VEGETATION

Shalini Rajakaruna

Board of Study in Plant Sciences

Natural rivers together with their associated riverine habitats are considered as one of the most diverse, dynamic and complex ecosystems in the world. Vegetation is a key component of a riverine system, as it involves in regulating the microclimate, aquatic and terrestrial food webs and also a source of woody debris. Riverine plant communities show high diversity and also include rare plant species as well as plant species restricted to riverine habitats.

Any kind of disturbances can have a large impact on species diversity and abundance in any plant community [1]. Riverine communities experience two main types of disturbances: natural disturbances and anthropogenic disturbances. Natural disturbances in riverine ecosystems include fluvial disturbances due to flooding or debris flow, canopy gap creation due to falling trees and landslides [1]. Anthropogenic disturbances can be caused by construction of dams and reservoirs across rivers, clearing for agriculture, sand mining, excessive livestock and human [2]. Alterations of flow regimes due to damming can affect riverine communities in the downstream of dams and reservoirs. Riverine ecosystem is broadly defined as the boundary of the river channel that is periodically flooded and dried out [3]. Therefore, the river margin communities are highly influenced by the changes in hydrology and flow patterns. As a result, riverine communities are considered as good indicators of the environmental changes caused by long-term river flow regulations [3]. Large dams can reduce the frequency and the intensity of overbank flooding in downstream areas, and also it reduces the groundwater recharge in riverine zones. The groundwater level is often considered as a critical factor contributing to the maintenance of riverine zones. When dams are built to facilitate the diversions of water, downstream channels and streams are left with significantly reduced water flows. As riverine plant species are adapted to moist habitats, they are relatively intolerant to water stress compared to other terrestrial plants. Therefore, repeated or prolonged reduction of water flow from the river systems can cause severe impacts on riverine vegetation. Another important issue is the island formation in formerly active floodplains, which is a common occurrence in regulated rivers. The island formation results widening of the channels and narrowing of the riverine forests along the river banks [4]. Biological invasion has been identified as a threat to all types of ecosystems throughout the world. Studies revealed that riverine habitats are more prone to invasion by alien plant species compared to many other ecosystems [5]. Dam-induced flow alteration is considered as a major factor promoting invasion of non-native species in riverine and aquatic habitats [6]. For instance, according to a study carried out in arid southwestern United States, the deep rooted, stress adapted invasive shrub *Tamarix sp.* is more adaptive than *Populus* and *Salix* which are common riverine species, to survive in deep alluvial water tables caused by river regulation [7]. A study carried out in San Pedro River in USA also has showed dominance of invasive, *Tamarix ramosissima* as a result of hydrological changes [6].

However, over three decades, since the initiation of the Accelerated Mahaweli Development Project (AMDP) in Sri Lanka, which involved in construction of five major dams and reservoirs across the Mahaweli River and some

of its tributaries, a comprehensive evaluation of the impacts on riverine vegetations has not been carried out. It is important to study whether the flow alterations in river Mahaweli have changed the composition and distribution of riverine vegetation in downstream area or not. Such information can be useful in implementation of conservation practices to restore riverine plant communities in the future.

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DOES PLANT INVASION ALWAYS AFFECT THE ECOSYSTEM NEGATIVELY?

Inoka Piyasinghe

Board of Study in Earth Sciences

Intentional and unintentional introduction of plants to areas outside their natural range can become invasive with time. With time, these invasive alien plant species (IAPS) can establish and become naturalize in their introduced range. Once integrated into native communities they can disrupt biodiversity and ecosystem functions [1, 2]. The impacts of invasive plants received much attention during the last decade due to their devastating effects such as suppress or eliminate native species, biodiversity losses, alterations of ecosystem structure and functions [3, 4]. Moreover, they cause huge economic impacts in sectors like agriculture, forestry, fisheries and health [5-7]. The IAPS seems to possess superior competitive ability over other plants such as higher growth rates [8–10], allelopathic effects [11, 12], higher litter quality and litter loading [13, 14] which eventually leading to their success in introduced range.

Impacts on Biodiversity conservation

Many research outcomes so far have highlighted the negative impacts of IAPS and are confined few plant species in restricted regions and environments [17]. However, a little is known about their positive impacts on their invaded habitats [12,15]. The positive impacts of AIPS are possibly underestimated and often perception biased [16]. Plant invasion may support the establishment of native communities in disturbed or degraded ecosystems such as landslide areas, abandoned plantations, lands integrated with anthropogenic activities (lands prone to Fire, chena cultivation) [17,18]. A meta-analysis revealed that invasive plants facilitate the establishment of native plants on highly degraded habitats thereby providing nursing effect to emerging seedlings through enhanced micro-habitat conditions [19]. A study conducted in a degraded grassland in the Knuckles Conservation Area of Sri Lanka revealed a higher abundance of forest tree seedlings under the canopy of the invasive shrub, *Austroepatorium inulifolium* compared to that of a less-invaded grassland indicating a facilitative effect of *Austroepatorium* invasion on the forest re-establishment of these grasslands [20]. They suggest that *Austroepatorium* has improved micro-climatic and edaphic conditions on these highly degraded grasslands thereby enhancing the chances of forest tree establishment. Furthermore, plant invasion could significantly enhance C and N pools through higher quality litter production, thereby increasing the soil nutrient availability in invaded landscape [21]. Alteration of soil nutrient status may facilitate the sapling growth of native communities [22,23]. A study conducted in north eastern Australia shows that initially grasses out-compete rainforest seedlings, but once they established, tree seedlings can out-compete the grasses [24]. They suggested that understanding nature of interactions between plant groups is critical in practical applications in restoration trials to achieve rapid reforestation on degraded agricultural lands [24]. The information suggests that the plant invasions have positive outcomes especially on degraded ecosystems. However, these positive outcomes depend on the species involved and the habitat concerned. Such positive outcomes can be used in restoration interventions in degraded landscape with caution to avoid any repercussion in the future.

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WEED AND CROP MIMICRY

Yasoja Athugala

Board of Study in Plant Sciences

Weed Science Society of America has been defined weed as any plant that is objectionable or interferes with the activities or welfare of human [1]. Further, they are recognized as unwanted economic pest in agriculture fields. Because of this, when farmers grow crops intentionally and manage them to obtain useful material, weeds come out associating the crops without human influence and they compete with crops for the limited resources such as light, water, nutrient and space in the field [2]. It causes to reduce the crop yield and increase the labor, machinery and herbicide cost. For example, USA farmers annually spend \$6 billion for herbicides and tillage to control weeds [3].

Although, weeds are considered as natural enemies in the agriculture field, there are some useful benefits provided by them in spite of their negative impacts (Table 1).

Table 1: Direct negative impacts and benefits of weeds in the agricultural field.

Negative Impact	Benefit
Reduce crop quality by contamination	Soil stabilization
Reduce crop yield	Habitat and feed for wildlife
Serve as hosts for crop diseases	Nectar for bees
Provide shelter for pest	Aesthetic qualities
Limit the choice of crop rotation sequences	Add organic matter
Production of allelopathic substances for crops	Provide genetic reservoir
Production of toxic substances for animals or humans	Human consumption

Early weeds were naturally pioneer plants of secondary successions. As a result of ability to tolerate a range of biotic and abiotic constraints and ability to adapt quickly to a new habitat, they have the natural potential to become agricultural weed. The success of weeds depends on their broad environmental tolerance and phenotypic plasticity. However, weed species show one or more different and specific characters that have equipped them to compete with crops (Table 2).

Crop mimicry

Some weed species are specialized to a particular crop by resembling the crop morphologically, phonologically, or biochemically in the same habitat [4]. This phenomenon is known as crop mimicry of weeds. In this case, resemblance may have occurred due to the gene exchange from crop to weed [4]. Since some crop-weed associations are so intimate, controlling weeds without causing damage to the crop is very difficult. Morphological mimicry may be vegetative mimicry or/and seed mimicry. In vegetative mimicry, appearance of seedling and vegetative growth of weed plant simulates that of the associated crop (Figure 1). This is a good adaptation for the survival of the weed during manual weed controlling. In seed mimicry, weed produce seeds

which are similar to crop seeds in appearance, weight or/ and density. Most of the time, phonological mimicry (seed distribution happen in similar time) combines with the seed mimicry. On that reason, seed mimicry facilitates weed seeds to distribute secretly with their associate crop seeds. Since removal of mimic seeds using machineries or herbicide is very difficult, seed mimicry is more important than vegetative mimicry on survival the weed species.

Table 2. Specific characters of weeds that useful to invade in crop field [1]

Germination requirements fulfilled in many environments
Discontinuous germination
Abundant seed production
Continuous seed production
Great longevity of seeds
Tolerance of seed in a wide range of environmental conditions
Seed dormancy (to germinate in favorable condition)
Very high seed output in favorable environmental circumstances
Adaptations for short-distance dispersal and long-distance dispersal
Rapid growth through vegetative phase to flowering
Cross-pollination by unspecialized visitors or wind
If perennial, vigorous vegetative reproduction or regeneration from fragments
Ability to complete interspecifically by special means (rosettes, choking growth, allelochemicals)

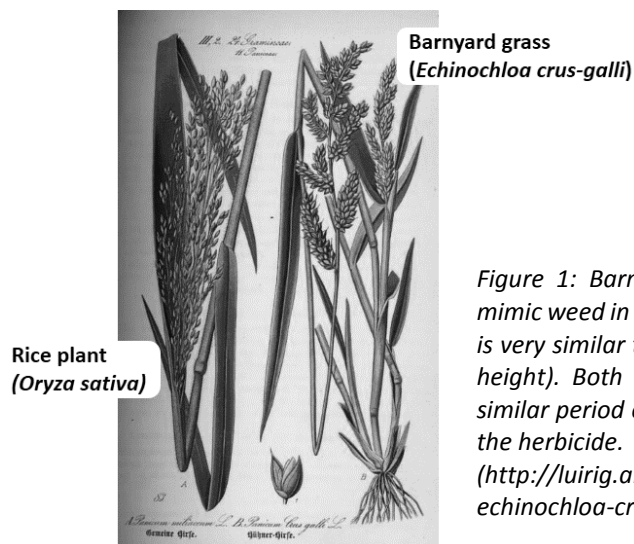


Figure 1: Barnyard grass (*Echinochloa crus-galli*) is a one of mimic weed in the paddy field in south Asian countries. This plant is very similar to rice plant in morphologically (color, shape and height). Both rice plant and Barnyard grass produce seed in similar period of time. Currently they are becoming resistant to the herbicide.

(<http://luirig.altervista.org/cpm/albums/thome/thome00144-echinochloa-crus-galli.jpg>)

Herbicide resistance in weeds forms as a result of biochemical mimicry of weeds. According to the International Survey of Herbicide Resistant Weeds, there are 245 species with resistant to herbicides and herbicide resistant

weeds have been reported in 86 crops in 66 countries [5]. Reference [6] has stated that there are 116 weed species with resistant to the acetolactate synthase (ALS) and 21 species are resistant to glufosate.

Although, animal mimicry has been well documented, plant mimicry has received less attention. Further, virtually experimental studies are deficient on this type of coevolutionary phenomenon in weeds, while most reports in the literature have merely document the form of resemblance between crops and weeds [4].

Weed communities in crop fields frequently differ in species diversity due to adaptive strategies of weed population diversified by agricultural practices [4]. Therefore, increase of use of herbicide and development of sophisticated seed cleaning machinery will be replaced current mimicry with another specialized agroecotypes of weeds in the next genera.

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MANGROVES IN SRI LANKA

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Mangroves are among the most productive ecosystems in the world. In Sri Lanka mangroves occur along the sheltered inertial coastlines associated with estuaries and lagoons [1] (Figure 1). The largest tracts of mangrove habitats in Sri Lanka are found in Puttlam Lagoon, Kala Oya basin and Trincomalee. Mangroves are associated with woody, seed bearing and highly specialized plants. Mangroves exist in harsh environments with anaerobic soils, tidal currents, high salinity, high temperature and strong winds 30 to 35 °C). Therefore, to survive and grow under such environmental conditions mangrove plants have developed many morphological and physiological adaptations [1].

List of adaptations in mangrove plants

- Xerophytic leaves with thick cuticle to reduce transpiration under high light intensity
- Succulent leaves to store water
- Salt secreting glands on leaves to remove excess salts
- Prop roots to anchor the plants to the unconsolidated substrate
- Air breathing peg roots, knee-roots, prop roots with lenticels for gas exchange
- Vivipary to ensure the seedling establishment under harsh conditions

Mangrove flora can be categorized as true mangroves and mangrove associates. True mangrove species grow only in mangrove environment and do not extend into terrestrial plant community whereas mangrove associates are found within or in the peripheral areas of mangrove wetlands. *Avicennia officinalis*, *Avicennia marina* (Avicenniaceae), *Exoecaria agallocha*, *Exoecaria indica* (Euphorbiaceae), *Lumnitzera racemosa*, *Lumnitzera littorea* (Combretaceae), *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera cylindrica*, *Bruguiera gymnorhiza*, *Bruguiera sexangula* (Rhizophoraceae), *Xylocarpus granatum* (Meliaceae), *Sonneratia caseolaris*, *Sonneratia alba* (Sonneratiaceae), *Scyphiphora hydrophyllacea* (Rubiaceae), *Pemphis acidula* (Lythraceae), *Heritiera littoralis* (Sterculiaceae) and *Premna integrifolia* (Verbenaceae) are true mangroves [1, 2]. *Acrostichum aureum* (Fern), *Nypa fruticans* (Palm), *Acanthus ilicifolius* (Acanthaceae) and *Clerodendron inerme* (Verbenaceae) are common mangrove associates found in Sri Lanka [2].

Mangroves provide many ecosystem products and services. They provide habitats, feeding grounds, nursery and hunting grounds for animals, protect the lagoons and the estuaries from erosion, reduce pollution of near-shore coastal waters by trapping pollutants, provide recreational grounds and provide opportunities for bird watching, ecotourism, field laboratory for researchers [3]. Further they provide food and fodder for animals, medicines, pigments (Tannin), fuel wood, timber for constructions, furniture and as boat building materials [1, 2]. Even though there are many awareness programs on 'importance of mangrove conservation', in Sri Lanka they are destroyed at an alarming rate due to the construction of shrimp farms, agricultural expansion, urbanization, unregulated discharge of pollutants, waste disposal, illegal constructions and mass tourism [1-3]. Many actions

have been taken by the Department of Wildlife Conservation, Forest Department, Central Environmental Authority and Coast Conservation Department in Sri Lanka to conserve remaining mangrove patches in Sri Lanka [3]. These conservation activities involve the establishment of the Nature Resource Center at Pambala and Mangrove Education Center at Maduganga. Other activities involved are, the establishment of mangrove nurseries, restoration of mangrove forests in lagoons and estuaries, training community leaders, educating, developing and improving skills and attitudes of villagers who are residence of nearby mangroves on, ‘mangrove conservation’ [3].

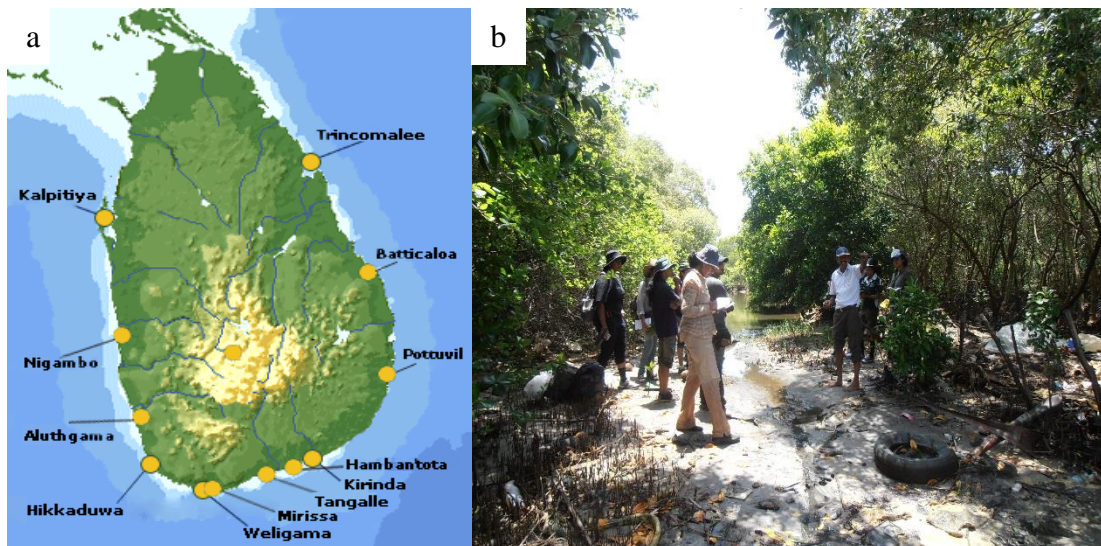


Figure 1: a) Distribution of mangroves in Sri Lanka and b) Learning about mangrove ecosystem at Kadol kale, Negombo Sri Lanka.

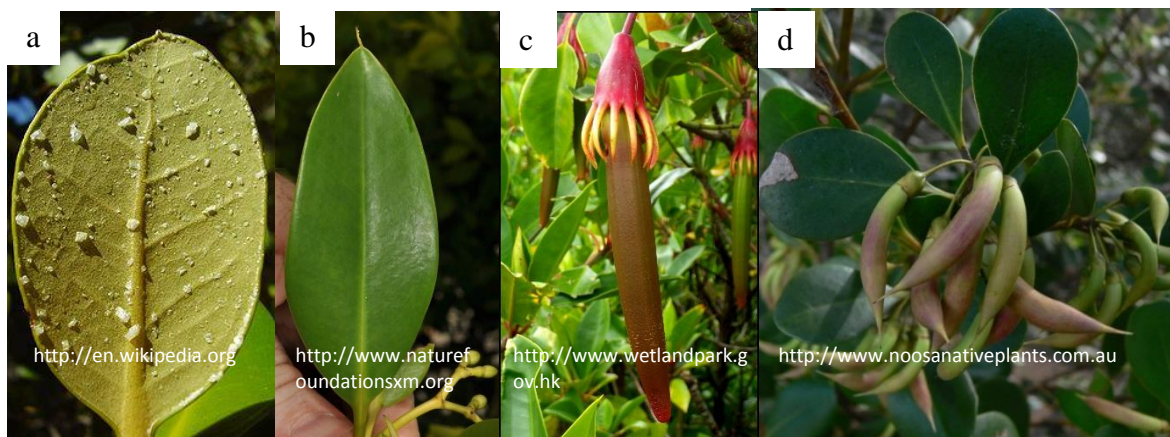
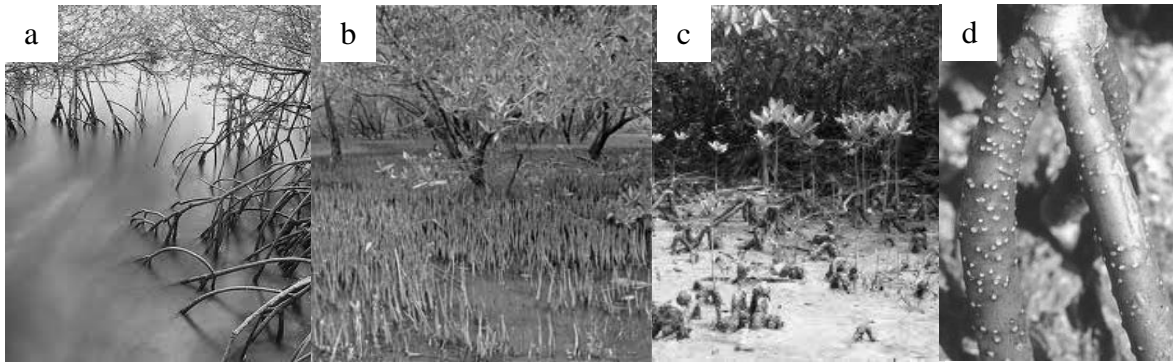
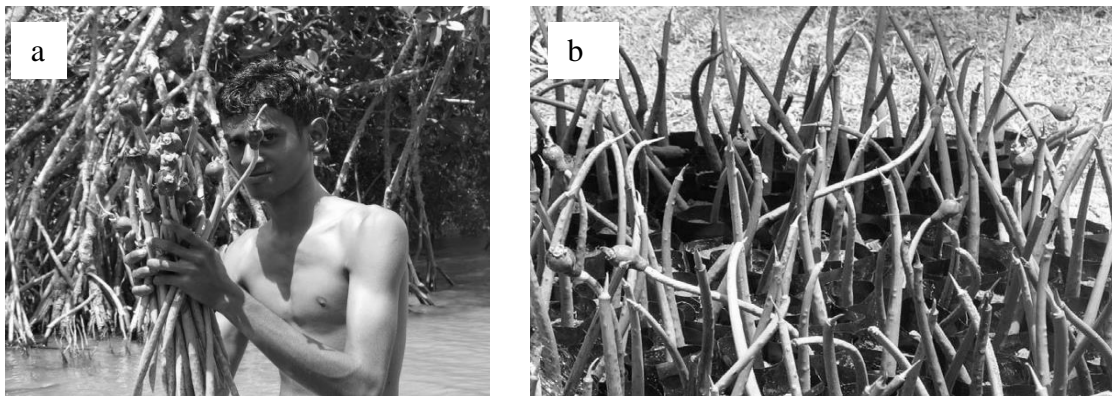


Figure 2: a) Salt secretion by mangrove leaf (*Avicennia* sp.), b) Thick leathery leaf (*Rhizophora* sp.), c) True vivipary (*Bruguiera* sp.) and d) Crypto vivipary (*Aegiceras* sp.).



<http://www.wetlandpark.gov.hk>

Figure 3: a) Prop roots (*Rhizophora* sp.), b) Peg roots (*Avicennia* sp.), c) Knee roots (*Bruguiera* sp.) and d) lenticels on prop root.



http://www.iucn.org/about/union/secretariat/offices/asia/asia_where_work/srilanka/

Figure 4: Restoration of mangroves a) Collection of hypocotyls for restoration purpose and b) established nurseries of mangroves.

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THE ‘DANCING’ PLANT: *CODARIOCALYX MOTORIUS* (HOUTT.) OHASHI

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Board of Study in Plant Sciences

Codariocalyx motorius (or *Desmodium gyrans* (L.f.) DC.) also known as the ‘dancing’ plant, telegraph plant, or semaphore plant, belongs to the Fabaceae family. It is often listed as one of the top 10 most unusual plants in existence. The reason for the fascination of the plant is its ability to rotate its small leaflets which are at the base of each larger leaf following the warmth of the sun. In Sri Lanka, this plant is commonly known as “Praanajeewa” due to its movements resembling life within the plant.

C. motorius is a tropical Asian shrub which is widely distributed throughout South Asia including Sri Lanka, as well as in East and East-Southern regions of Asia.

This plant is famous for its rapid movement of leaflets and it exists within a period of about three to five minutes. The leaves move up and down rhythmically, as if the plant is dancing or sending out telegraphic messages. Therefore, the necessity of a time lapse camera to see the movements can be avoided, as the rapid movements are observable to the naked eye. The leaf system of *Codariocalyx motorius* consists of a terminal leaflet and a maximum of two lateral leaflets, all on the same stalk [4]. A set of one larger and two smaller leaflets are connected by a “hinge,” which allows the leaflets to lift and rotate themselves. Moreover, the plant also produces small, purple coloured flowers.



Figure 2: Leaves of *C. motorius*
(<https://typicalgardener.files.wordpress.com>)

However, the ‘dancing’ effect occurs only in the presence of sunlight. Two small lateral leaflets at the base of each larger leaf, move constantly along an elliptical path, sampling the intensity of sunlight, and directing the larger leaf to the area of most intensity allowing it to absorb the maximum energy from the sun. Sometimes, the plant will react to the slightest touch or small vibrations as well. Some people believe that they can get their ‘dancing’ plant to dance to music. This may occur as the plant reacts to the vibrations of the tune. In the evening or when it is dark, the leaves droop downwards, just like in most legumes.

Although rhythmic movements of the lateral leaflets in this plant have been studied intensively, its functional significance still remains unclear. The movements are due to swelling and shrinking of motor cells in pulvini at the base of these leaflets. Electrophysiological and chemical perturbation studies indicate that ion and water movements cause such swellings and shrinking across the cell membranes of the motor cells



Figure 1: A plant of *C. motorius*
(<http://www.karnivores.com>)



Figure 3: Flowers of *C. motorius*
(<http://www.svetbiljaka.com>)

located in the pulvinus at the leaflet base [1]. Electrical potentials across the motor cells oscillate and maintain a constant phase relationship with the leaflet positions. The fluctuations in the electrical potentials across the motor cells are due to the uptake and release of ions, especially K^+ and Cl^- . A considerable amount of K^+ is also shuttled from one part of the pulvinus to the other, acting as a cation reservoir. The motor cells oscillate between electrically polarized and depolarized states. The state of depolarization causes K^+ and H^+ efflux while hyperpolarization causes K^+ and H^+ influx into the cells. The K^+ fluxes are believed to be responsible for the osmotic movement of water across the pulvinus, which in turn results in volume changes in the pulvinus and the observable leaflet movement [4]. However, an extensive investigation regarding the functional significance of ultradian rhythms of this plant is still to be done.

The lateral leaflet oscillations of *C. motorius* are sensitive to external stimuli such as, sun light, temperature, vibrations, electromagnetic fields [5], DC currents or 27-MHz radio frequencies [3], which can affect the biological clock that regulates the ultradian rhythm of leaflet movements of the plant.

Codariocalyx motorius is documented as used for treating of many diseases. It has traditionally been used in Chinese Medicine to treat various ailments such as rheumatism, cough, malaria, pyrexia, dysentery, hepatitis, haemoptysis, etc. Its roots possess the highly active antioxidant substance which can be used for the treatment of oxidative stress-related diseases [2]. A juicy extract from leaves and flowers of this plant utilized as a home remedy to treat wounds. Interestingly, this plant also contains a wide variety of alkaloids that can be used to make pharmaceuticals. Furthermore, its stem and roots contain N,N-dimethyltryptamine and 5-methoxy-N,N-dimethyltryptamine. In addition, the 'dancing' plant can be grown in home gardens as a fascinating ornamental plant.

The plant is described in detail in Charles Darwin's *The Power of Movement in Plants* in 1880's. The book pointed out that *Codariocalyx motorius* as one of the natural wonders that will remain in science books and documentaries as a nature's mystery.

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ANIMAL SCIENCES

DEVELOPMENTAL MALFORMATIONS: A SILENT KILLER OF AMPHIBIAN POPULATIONS?

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Board of Study in Zoological Sciences

Having abnormalities is a normal condition in any population, and amphibians are no exception. Abnormal development often leads to permanent structural defects and these are termed malformations. Reports of malformed amphibians are not unheard of, with some reports dating back to the early 18th century. These observations, however, involved one or few individuals. The story took a sudden turn in 1995 when a group of middle school students from Minnesota, USA, discovered a small pond in which half the frogs had severe malformations, including missing and extra limbs [1]. This incident received immediate attention from both researchers and media since this was the time a “mass malformation” was reported.

Amphibians are considered as excellent bio indicators [2]. Unshelled eggs, aquatic tadpole stage, and permeable skin of tadpoles and adults make amphibians vulnerable to both aquatic and terrestrial hazards. This raised concerns over the causes and implications of amphibian malformations on human health and wildlife. Researchers in other places also began their studies to see if this incident was an isolated one, but it turned out that amphibian malformations was a widespread trend both in USA and other continents such as Europe, Asia and Australia [1].

What causes malformations?

In any population, a few individuals may have malformations resulting from trauma, genetic mutations or developmental disturbances, and this rate is usually below 5% and usually do not involve extreme malformations [3]. Recent surveys have shown that in many populations the frequency of malformations exceed 5% and sometimes reach 80% [3]. Generally malformations in limbs, especially in hind limbs are the commonest type observed in nature [1] (Figure 1). It is clear that this high prevalence of severe malformations could not be attributed to background levels of malformations. Intensive studies have identified chemical contaminants [4], exposure to UV-B radiation [5], and parasitic infections⁶ as main causes of amphibian malformations. Interactions among above factors are also considered of great importance as no single factor alone can account for all types of malformations seen in nature [3].

Ecological Implications

Exposure to high levels of UV-B radiations, chemicals and trematode parasites often causes high rates of mortality in amphibian embryos and tadpoles [4-6]. Sub lethal exposure to these stressors results in development of malformations. In what ways can these malformations affect amphibians? Evidence suggests that malformations cause death of amphibians in direct and indirect ways. Malformed amphibians may survive well under laboratory conditions, but in nature they suffer reduced survivorship as malformations impair the locomotion [3]. Therefore, severely malformed ones are not likely to survive to adulthood and sexual maturity [3]. Not only the adults, but also tadpoles can experience adverse effects of malformations. Malformed larvae

are known to experience greater mortality than normal larvae [7]. This is supported by the observation that larval amphibians show higher frequencies of malformations than that in adults from the same habitat [7]. Edemas and tail muscle malformations affect the swimming ability of the tadpoles making the tadpoles vulnerable to predation thereby causing indirect mortality [8]. Although some tail malformations disappear upon metamorphosis, edemas upon rupturing are often fatal and causes direct mortality of tadpoles [6]. Reduced activity of tadpoles resulting from malformations decreases the foraging activity while increasing the competition and predation risk. These mortalities might be a reason why we do not see such large number of malformed amphibians in nature although laboratory studies produce high frequencies of malformed individuals.

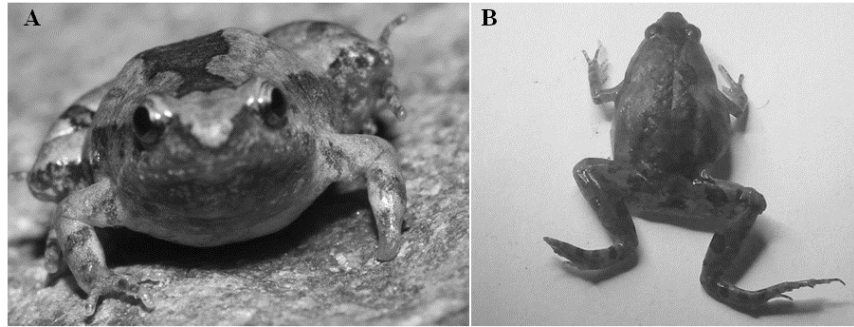


Figure 1: Malformed limbs of *Microhyla ornata*, collected during a field visit from Anuradhapura. A) apody (missing hand), B) brachydactyly (shorter toes)

Although long term data are not available to conclusively link malformations with amphibian declines, occasionally malformations are associated with declining populations [3]. It appears that mass malformations can eventually impact a larger portion of the amphibian population by causing death directly or indirectly, and are likely to contribute to the observed declines in amphibian populations [1].

Acknowledgements

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AVIFAUNAL DIVERSITY OF UDAWATTA KELE: AN URBAN FOREST RESERVE IN THE KANDY DISTRICT

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Board of study of Zoological Sciences

Sri Lanka is a bird paradise. Up to date, 453 bird species had recorded from Sri Lanka. Among them 237 species are breeding residents and 216 species are migrants. Out of 237 resident species, 27 species are endemic to the country [4]. Kandy is the capital of the central hill country of Sri Lanka. There are six bird distribution zones in Sri Lanka. Udawatta Kele belongs to the mid country wet zone. Udawatta Kele forest reserve is an artificial forest located at the very heart of the city of Kandy in Sri Lanka. In 1856, this areas was named as a nature reserve and in 1938 as a sanctuary. Extent of this forest is about 102.8 ha. Jack and Mahogani plantation was begun and maintained from 1940 by the Forest Department of Sri Lanka and currently the forest is protected under the Forest Department. Since the surroundings of the Udawatta Kele are highly urbanized, the wildlife of the area is blessed from this forest islet. It provides many habitats for animals, especially birds. Since it is an easy destination, many studies have been carried out based in Udawatta Kele. However, only a few scientific studies on the avifauna in Udawatta Kele have been carried out to date. According to Ellepola [1], twenty three bird species recorded in Udawatta Kele, including five endemic species.

The objective of this study was to study the avifaunal diversity of Udawatta Kele forest reserve. The study was conducted in Udawatta Kele forest reserve, Kandy, Sri Lanka. Line transects were used to collect data. Transects were established along the permanent walking trails, covering most of the area of the forest. Opportunistic point counts were also taken for data collection. Birds were observed using a pair of Nikon monarch[®] binocular. Also birds were identified by their calls and songs. Identifications were confirmed by using Harrison [2]. The survey was carried out for one year, from January to December 2014, through both migratory and non migratory period. Data were collected from early morning to noon when birds were more active. Feeding habits of birds were also observed during the survey. According to the food habit birds were categorized into groups. Furthermore, the habitat preferences of each bird were identified. Thus, birds were also separated into groups based on their habitat preference.

A total of 51 bird species belonging to 28 families were recorded during the study. Of the 51 species, 47 species were breeding residents, four species and one sub species were migrants (Figure 3). The study encountered four endemic bird species and two proposed endemic species (Figures 1 and 2). Fifty per cent of the recorded families (n = 14) had only one species, nine families (32.14%) had three species, two families (7.14%) with three species, two (7.14%) with four species and one family (3.57%) had five bird species. Of the 51 bird species, two species were near threatened, i.e. Sri Lanka Emerald-collared Parakeet (*Psittacula calthropae*) and Black Eagle (*Ictinaetus malayensis*), and one species was nationally threatened (Black-throated Munia (*Lonchura kelaarti*) according to IUCN [3].

Most of the recorded species were canopy and sub canopy dwellers. Of 51 species 32 species were canopy and sub canopy dwellers (canopy=14, sub canopy=10, canopy and sub canopy=8). The remaining 19 bird species were more commonly recorded closer to the ground. Most of the species were secondary forest associated species. Few species preferred grassland and water body habitats. During the study six main bird feeding guilds were recorded, i.e., frugivores, nectivores, seed eaters, insectivores, carnivores, and omnivores. Most of the birds were insectivores (n=19), followed by omnivores (n=11).

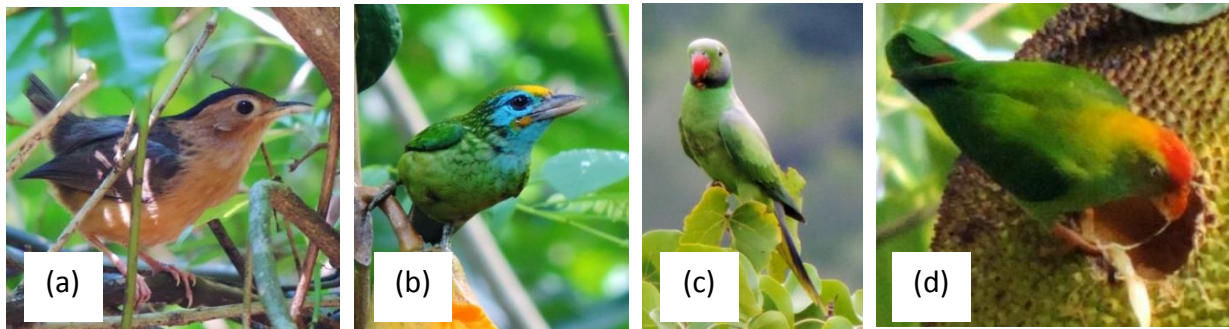


Figure 1: Endemic bird species in Udawatta Kele. (a) *Pellorneum fuscicapillus* (b) *Megalaima flavifrons* (c) *Psittacula calthropae* (d) *Loriculus beryllinus*

Most of the birds utilize this landscape as their roosting and nesting areas. Also some migratory birds had chosen this area as their destination for spending their winter in breeding lands. Number of endemic bird species is low in the area. And the recorded endemic species are common species. Low habitat heterogeneity and lack of specific habitats and high degree of urbanization of the surroundings have may probably reduced the number of endemic species.

Most of the forest covered with a constant canopy. This canopy cover decreases the amount of sunlight reach to the ground layer. Therefore, most of the forest areas lack an understory and ground layer vegetation. A healthy understory can be observed in areas where in minimal canopy cover. Most of the forest ground was covered with fallen leaves. This ground structure enables the ground dwelling birds for camouflage.

Most of the recorded bird species were insectivores and found in canopy and near to canopy. This layers rich in insects, flies and plant bugs; which were their main food source. Also some insectivores recorded at ground. Fallen leaves and branches were ideal places for colonize insects and other invertebrates. Hence, ground was good feeding place for insectivore birds.

Habitat heterogeneity of the forest is low, but it provides some distinct habitats. Secondary forest, grassland, water bodies are some of these habitats. This habitat variation enables to increase the species richness of the area. Since most of the forest area covered with a thick canopy, locating birds was much difficult. Also the visibility decreased by the low light conditions inside the forest. But most bird species are noisy and make calls and songs. These bird calls helps to identify bird species even the individual is not visible.



Figure 2: Proposed endemic species in Udawatta Kele. (a) *Megalaima rubricapillus* (b) *Chrysocolaptes lucidus*



Figure 3: Migratory species in Udawatta Kele. (a) *Pitta brachyura* (b) *Muscicapa muttui* (c) *Dendronanthus indicus* (d) *Phylloscopus magnirostris*

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CONSERVATION AND MONITORING OF FISHING CATS (*PRIONAILURUS VIVERRINUS*) IN THE HILL COUNTRY OF SRI LANKA

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The Fishing cat *Prionailurus viverrinus* (Carnivora: Felidae) is the second largest endangered wild cat inhabiting hill country wet zone and dry zone forests in Sri Lanka. They can be also found in the Himalayan foothills, along India's east coast, Indonesia's island of Java and in Pakistan [1]. The fishing cat is considered as a medium sized cat categorized along with some other cat species under the umbrella term *Prionailurus*, and the members of this family are characterized by noticeable stripes and spot patterns on the head, face and body. Fully grown male is about 70-76 cm in length (body length) and weights 8 to 14 kg, whereas the female weight from 5 to 9 kg [2].

The coat is a camouflaging grizzled grey and the soft coat is tinged with olive-brown and has unique spots and stripes. Six to eight black lines run from the forehead to the neck and break up into shorter lines and longitudinal spots on the shoulders. It has broad head with vertical markings above eyes. The flattened nose is a deep brick colour. Its short, muscular tail, marked with about six or seven incomplete dark bands, distinguishes it from the leopard cat (*Prionailurus bengalensis*). The double coated fur has water resistant ability that is important to keep the body dry while diving into the water to catch fish. Its legs are short but equipped with long claws that function as fishing hooks [3].

The local populations are highly threatened due to an array of threats of which road kills, poisoning, hunting pressure, and habitat destruction are prominent. Road kills are often the result of high degree of fragmentation of the species' habitat due to rapid expansion of the national road network [4, 5]. The species is often victimized by local communities due to misconception. Fishing Cats are also highly sensitive to degradation of wetlands, which is one of their key habitats. This species is a good focal species for the conservation and management of protected areas since they are habitat specialists and require marshy areas that have an adequate prey base [6-8]. They also qualify as a flagship species due to their charismatic value, but are fast earning a negative reputation due to their conflicts with the people living around protected areas [9, 10].

The study was carried out in Gannoruwa Forest Reserve, Upper Hanthana Forest. In addition, observations from three districts in Central province were used. During the study population trends, ecology, and threats were monitored by camera trapping, scat collections, pug mark censusing, veterinary records and interviews with local community [12, 13]. Threat analysis was done for identifying the problems in different locations. Then Niche modelling of fishing cats was carried out for study areas using ArcGIS (10.1) and MODIS NDVI data as this will be important in locating potential fishing cat conservation sites and in environmental impact assessments in the future.



Figure 1: Fishing cat in Gannrouwa Forest Reserve (5.27 a.m.)

Awareness programs and youth camps were organized targeting school children and villagers in the target sites and school children were selected as the target audience considering their undisrupted thinking process and convincing ability. The first awareness rising program was held on 27th February 2014 to educate school children about conserving our wild cats. And it was a first step of a massive awareness program organized by the Fishing Cat Conservation Project. As the second program Fishing Cat Youth camp was held on 9th of June in Maragamuwa natural forest for 25 selected university students who were willing to contribute to future awareness rising programs. On this program students are educated with field techniques, general description, conservation actions and how they could work on conservation.

Placing road signs in major road kills area are currently ongoing. This will be completed within the next three months and after that this will spread throughout the country with the permission of Road Development Authority.



Figure 2: Rusty spotted cat in Gannoruwa Forest Reserve

Results to date indicate 28 recordings of fishing cats within the three districts considered for the research. Road kills, poaching, electric fencing and poisoning are the main threats they faced throughout the area. Kandy district holds the highest number of kills in the central province which was eight road kills two poaching and one electric fencing deaths in past 18 months.

During the study period 13 scat samples were collected. Eight scat samples were collected from Gannoruwa Forest Reserve and Upper Hanthana Forest and other five samples were collected from other districts including Kandy. Scat samples were analysed using hand picking method and microscope. According to results four preys were identified to family and order level. Such as Family Soricidae, Parathelphusidae, Oorder Diplopoda and Blattodea.

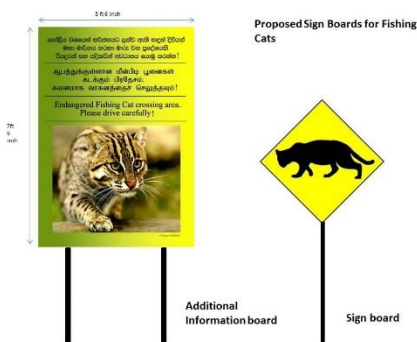


Figure3: Proposed signs for fishing cats



Figure 4: Awareness programs

Discussion

The highest numbers of threats are due to human caused activities and most are recorded from the Kandy District. This may be due to the habitat fragmentation caused by expanding highway system in the area.

Poisoning and electric fencing was occurring due to misunderstanding and misconception of people. Awareness rising is the best solution to overcome this problem.

Eight photographs of fishing cat were obtained using camera traps after 1200 trapping hours in Gnruruwa Forest Reserve. Camera trapping helped to identify the home ranges of fishing cats by using capture software. Most of the positive records were found through vegetation which is close to home gardens.

At the same place fishing cat and Rusty spotted cats (*Prionailurus rubiginosus*) were recorded in a same camera trap and rusty spotted cat was recorded marking his territory using urinary sparing. This proves that they were territorial and marking their own territory to prevent the territorial overlapping.

Fishing cats can often survive on alternative food such as crustacean's, cockroaches, rats and mice when it becomes hard to find proper food. Fish becomes less common on stream systems at higher altitudes.

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NATURAL SCIENCES

SUPERHYDROPHOBIC AND OIL-REPELLENT SURFACES WITH NANOTECHNOLOGY

M. M. M. G. P. G. Mantilaka

Board of studies in Chemical Sciences

Products with oil-repellent (oleophobic) and water-repellant (hydrophobic) surfaces have become very attractive and popular in recent years. Therefore, many industrialists and researchers are working on fabrication and manufacture of products with hydrophobic and oleophobic surface finishes. Some of these products are papers [1], electronic devices including hard disks [2], optical devices [3], pipelines [4], glass products [5] and various textiles [5-7]. These surfaces are resistant to stain because dirt particles are usually dispersed or dissolved in liquids and the surfaces repel the liquid. As a result, dirt particles cannot be attached to the surfaces. Therefore, the products containing hydrophobic and oleophobic surfaces are always clean. Surfaces with extreme hydrophobicity are known as superhydrophobic surfaces. The concept of superhydrophobicity is taken from natural water-repellency of lotus leaf and hence, it is known as lotus effect.

The contact angle between the hydrophobic surface and the water drop on the surface is measured in order to determine the hydrophobicity of materials. The water-contact angle for hydrophobic materials must be over 90° and for super-hydrophobic materials, the water-contact angle should be greater than 150° [8]. The relationship between contact angle (θ) and forces acting on water drop is given in Equation 1 [9]. The parameters described in Equation 1 are graphically shown in Fig. 1.

$$\gamma_{SG} = \gamma_{SL} + \gamma_{LG} \cos \theta \quad \dots (1)$$

Where, γ_{SG} = interfacial tension between the solid and gas; γ_{SL} = interfacial tension between the solid, liquid; γ_{LG} = interfacial tension between the liquid and gas

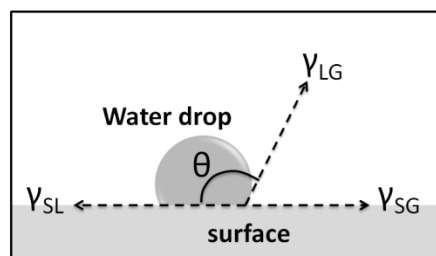


Figure 1: The relationship between each parameter given by Equation 1

The surface free energy of the substrate should be lower than the surface tension of the water in order to introduce hydrophobicity to the substrate. Pure water has a high surface tension about 72 mN/m. Therefore, surface free energy of the surface must be lowered to 24-30 mN/m for the fabrication of hydrophobic surface. In the case of oleophobicity, the surface free energy of the substrate should be lower than 20 mN/m since the surface tension of oils is usually 20-30 mN/m [10]. Surfaces with both oleophobic and superhydrophobic properties are more important [10, 11]. Therefore, nano-architected surface coatings with low surface free energies are fabricated on surfaces in order to prepare superhydrophobic and oleophobic surface finishes. Some of commonly used coating materials are fatty acids, polyhedral oligomeric silsesquioxane (POSS), polysiloxanes

with various functional groups and fluorochemical repellents [3]. An example for nano-architecture surface is shown in Fig. 2. Herein, inorganic nanorods such as zinc oxide and titanium dioxide have been grown on the surface of the product and then, above mentioned liquid repellent molecules have been allowed to self-assemble on nanorods. The intermediate inorganic material of nanorods should have an ability to bind with both surface of product and the liquid repellent molecules. Therefore, nano-architected superhydrophobic and oleophobic surfaces will cause a significant impact on industrial and economic development.

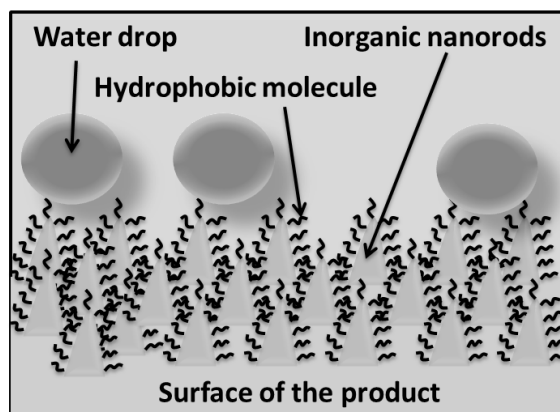


Figure 2: Example nano-architecture of superhydrophobic surface

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DEVELOPMENT OF NANO FERTILIZERS AS SLOW RELEASE FERTILIZERS

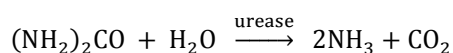
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Adequate soil Nitrogen is essential in agricultural soils to increase the crop productivity. There are vast varieties of Nitrogen fertilizers to fulfil the Nitrogen requirement for crop plants, which are commonly available in the market and most commonly they come in solid forms. These fertilizers can release nitrogen as readily water-soluble, inorganic forms, such as NO_3^- and NH_4^+ , which can readily be utilized by plants. Therefore, modern farmers tend to use high dosages of commercially available synthetic fertilizers to increase their crop productivity rather than using natural fertilizers such as organic fertilizers [1].

However, heavy usage of commercially-available, synthetic Nitrogen fertilizers has been now created many problems which may override their advantages associated with improved crop productivity. For instance, they could alter the natural equilibrium and the biodiversity of agricultural lands. Urea is one of the commercially-available, fast-release Nitrogen fertilizers, which is easy to use in agricultural fields. After adding urea to agricultural lands, addition of sufficient amount of water is essential for the solubilization and the absorption of Nitrogen as NH_4^+ and NO_3^- , by plants. Urea can dissolve in water within 48 hours after addition of a sufficient amount of water and is then converted to ammonium bicarbonate in the soil through the natural process carried out by the urease enzyme present in the soil, which is released by vast arrays of soil microbes [2].



In acidic soils, ammonia gas produced will be in its ammonium form while in basic soils, ammonia exists as ammonia molecules. As such, in soils of pH 7 to 8, part of this gas will be released to the atmosphere, if it is not protected, causing the so called green house effect. As such, added urea on the soil surface will lose 50% - 90% of its initial amount of Nitrogen within few hours of addition rather than being absorbed by plants, if it is not protected. In addition, the urea has a greater ability to move down along the soil profile and can directly runoff to natural water bodies. It also can create eutrophication of surface of water bodies, by increasing the growth of planktonic autotrophs which may be able to produce toxins (algal blooms- bloom forming cyanobacteria), changing the diversity of vascular plants, biomass and productivity of plants and water bodies, changing the water quality parameters which is unfavorable for consumers. This polluted water will also increase possible health risks during consumption of water and also it will decrease the aesthetic value of such whole aquatic ecosystems [3].

Therefore, the use of urea as a synthetic Nitrogen fertilizer will create more adverse effects than its advantages associated with the growth of plants; the disadvantages include the alteration of the natural Nitrogen cycle, soil health and soil microbial density, increasing the possibility for the green house effect. In order to overcome those difficulties, the soil incorporation of urea is essential for its use as a slow-release fertilizer, for the crop growth improvements [1]. At present, a mixed fertilizer has been developed, which includes urea along with the other fertilizers, as a combination of few essential elements, such as Phosphorous (P) and Potassium (K), as solid pills, to suppress its rapid release when it is used in its pure urea form. Modern technologies have been

developed to create slow-release fertilizers, with the aid of the development of nanotechnology. The conventional Nitrogen fertilizers contain particles of size exceeding 100 nm making them to be difficult to be absorbed by the plants, resulting low Nitrogen utilization efficiency (NUE) by plants. Hence, greater numbers of researchers have attempted to create urea-based, Nitrogen fertilizers to increase the NUE by plants. Then the nanotechnology has found a new configuration of fertilizers, known as nano-fertilizers, to increase the NUE several times over the synthetic polymer-coated, conventional slow-release fertilizers. In this sense, Kottegoda *et al.*, (2011) have developed a new fertilizer of urea modified with hydroxyapatite (HA) nanoparticles, which are encapsulated into the soft wood of *Gliricidia sepium*. Instead of urea alone, when it is used in combination with HA nanoparticles, $[(Ca_{10}(PO_4)_6(OH)_2)]$, it is then known as a compound fertilizer, which can fulfil dual roles as slow release Nitrogen and Phosphorous fertilizers [4].

Most important characters of the HA are Calcium (Ca) ions in the HA which has a greater potential to be replaced with the other positive ions of heavy metals such as Cadmium (Cd), Lead (Pb) and Silver (Ag) available in the soil which accumulated along with the commercially available inorganic fertilizers due to the greater application during agricultural and mining activities. In similar manner, negatively charged phosphate groups available in the HA complex have an ability to be replaced by the other heavy metals which are available in their negatively charged anionic form such as arsenate (AsO_4^{-3}) due to formation of more stable complexes between HA and most of the heavy metals.⁵ Then it prevents the leakage of heavy metals along the water table in to the ground water and runoff to the natural water bodies along with the rain water due to the accumulation of above mentioned complexes in the soil for a long time. Therefore, the encapsulation of N fertilizer with the HA nanoparticles may influence the prevention of accumulation and the pollution of water bodies and the ground water table from heavy metals [5]. HA can combine with natural polymers and synthetic polymers or any other compound, such as poly (methyl methacrylate), poly (acrylic acid) (synthetic) and cellulose, chitin (natural). It is important to make soil colloids along with the soil particles and humus particles which are important during the nutrient adsorptions which may increase the water holding capacity and the cation exchange capacity [6].

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SOLAR ENERGY AND SOLAR CELLS FOR FUTURE ENERGY NEEDS

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Board of Study in Chemical Sciences

Sun is the mass energy producer to the whole planetary system including the earth. Sun's energy is mediated via the solar radiation. It is in the form of heat and light. Sun is a gaseous sphere of hydrogen and helium. These gases are held inside the sphere due to strong gravitational forces exerted by the sun. So these hydrogen atoms tend to fuse into helium by nuclear fusion and by that solar energy is created at the core of the sun as the matter converts into solar energy during the nuclear fusion process. Finally, this energy is radiated into space as electromagnetic radiation as photons [1]. The amount of energy falls on to the earth is given by the **solar constant** which is approximately 1367.7 Wm^{-2} . However, when solar radiation passes through the earth's atmosphere, it acts as a filter absorbing some harmful radiation at the higher end of the electromagnetic spectrum such as gamma, x-rays and ultra-violet energy. Also, some part of the solar radiation is reflected away from the earth by the clouds and the sea leaving about space 1 kWm^{-2} of energy to reach the surface of the earth. However, insolation levels of specific locations of solar radiation depend on the latitude and longitude, time of the year and weather patterns. The countries located near the equatorial belt including Sri Lanka have high insolation levels. Higher the insolation more energy can be generated.

Solar cell is the device which has being used all over the world to generate energy from the solar radiation. It simply takes the photon energy and converts it to electricity by photovoltaic effect. The normal commercial solar modules consist of 72 cells and this number can be varied from manufacturer to manufacturer. These individual cells are connected in series and placed into a frame. Then protecting coating is introduced to the panel and this coating sometimes enhances the efficiency of the panel. Solar panels are rated based on the standard assumption of 1,000 Watts (= 1 kilowatt or 1 kW) per square meter of sunlight strikes the panel perpendicular to the panel (at a temperature of 25°C) [1]. This rating typically is shown on the manufacturer's data sheet as the maximum power or abbreviated as kWp (where p stands for peak or maximum kilowatts of electricity generated under the standard peak conditions).

The conventional solar cells are fabricated using silicon. Still they are the most abundant solar panels used in residential applications. There are variety of silicon solar panels such as monocrystalline silicon cells, polycrystalline silicon cells and amorphous silicon cells. Out of these solar cells, monocrystalline solar cells perform well giving around 24% efficiency value. But the initial cost is large due to its complex fabrication techniques. Moreover, these solar cells tend to decrease their efficiency values with the increase of temperature. However, the manufacture cost is reduced when it comes to polycrystalline and amorphous silicon solar cells as these solar cells do not need high pure silicon wafers. The efficiency values of these solar cells are lowered compared to monocrystalline solar cells but the durability with temperature is better than the monocrystalline silicon solar cells. Next, thin film solar cells appeared as the second generation of solar cells. Here direct band gap semiconductor materials such as cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS) are used and these thin film solar cells have only a few micrometer thicknesses. The

combination of less material and easy fabrication techniques have reduced the initial cost of this type of solar cells than the silicon based solar cells and their efficiency values are around 16% [2].

The newly emerged dye-sensitized solar cells also play a major role in today's photovoltaic industry as it can be fabricated using simple fabrication techniques using inexpensive materials [3]. Many studies have been carried out all over the world to enhance their efficiency values by introducing new semiconductor materials, new electrolytes and sensitizers. Currently it gives around 12% efficiency value.

As our country has a constant solar radiation throughout the year we have the potential to use solar energy to fulfil our energy needs. By constructing solar panels using easy fabrication techniques and abundant materials such as TiO₂ as used in dye-sensitized solar cells, the government would be able to supply electricity with a reduced cost to rural areas. Therefore, Sri Lanka has to do more studies on solar cell technology in order to face the future energy crisis.

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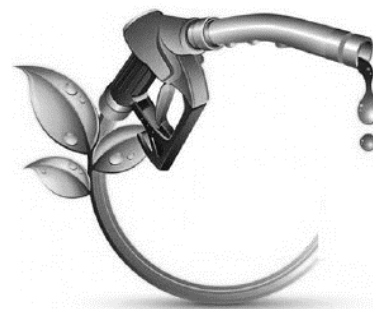
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CAN BIODIESEL SUBSTITUTE PETROLEUM DIESEL?

Mudassar Marso

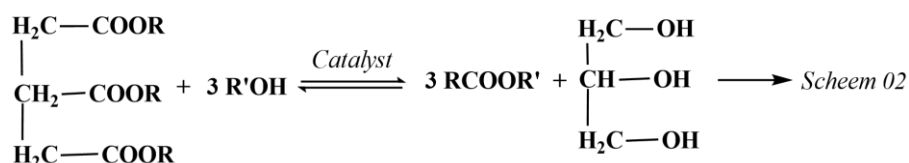
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World energy demand is increasing daily, as world population and their living standard go high. According to the International Energy Outlook 2014 [1] of U.S. Energy Information Administration, world liquid fuels consumption increases by more than one-third (33 MMbbl/d), from 87 MMbbl/d in 2010 to 119 MMbbl/d in 2040 (MMbbl - one million barrels). Even though an increment of liquid petroleum fuel consumption is expected, depletion can occur overtime due to non-renewable nature of the source. According to the statistics [2], world oil and gas stocks will be sufficient only for this century and coal for two or few more years. Uncleanliness is another big issue of fossil fuels. It makes huge impact on the human body as well as on the environment. From the mining stage to the final usage, it creates large and concealed damage on both communities. Even though non sustainability and uncleanliness affects petroleum fuel seriously, still world energy consumption mainly depends on petroleum based energy sources due to certain advantages such as its high energy density, easiness to extract, handle and use and its broad areas of applications.



Petroleum fuel is a mixture of a very large number; approximately about 17000 of different organic compounds (dominant Hydrocarbons). Among number of theories about the origin of petroleum fuel, the most acceptable theory is, it derived from ancient fossilized organic materials due to the application of high pressure and temperature. Biofuel is a type of energy source which has an organic composition. It derives from bio masses such as plants and animal materials and it can exist in the forms of solid, liquid or gas. Even though petroleum fuel and bio fuel seem to have a big difference, both fuels have the same organic composition and origin. Therefore there should be a possibility to meet a bio based solution for petroleum fuel.

Petroleum diesel is a part of crude oil and separated via fractional distillation process between 200 °C and 350°C at atmospheric pressure. It is a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule. Biodiesel is an alkyl ester (mainly methyl or ethyl) of naturally occurring long chain fatty acids which is called as Fatty Acid Methyl Ester (FAME).



In natural systems, mainly in plant and animal materials contain 18 to 22 carbon atoms components as free fatty acids (FFA) or triglycerides (TG) [3]. During the production of bio diesel, these bio molecules (generally called as

Fats) are converted in to a methyl ester of fatty acids (FAME) catalytically. There esterification (*Scheme 01*) for FFA or transesterification (*Scheme 02*) for TG can be used.

The main idea of synthesis of bio diesel from naturally existing oil is, the reduction of boiling point, in order to make the oil more volatile and then facilitate ignition at low temperature. To fulfill that purpose, structural changes of natural oil are done in chemical processing. As a result of those structural changes, intermolecular interaction types and molecular weight are changed and hence boiling point is reduced. Finally liquid oil having similar properties of petroleum diesel can be obtained. Since number of carbon atoms per molecule of naturally occurring fatty acid does not match with range of carbon atoms in petroleum gasoline (petrol), it is impossible to produce bio gasoline. Gasoline is more volatile and has low flash point than diesel.

Table 01 shows some important physical properties of two common biodiesel feed stocks, Petroleum diesel and Biodiesel (B100). According to the table, it is clear that, reduction of flash point (lowest temperature at which it can vaporize to form an ignitable mixture in air) during chemical processing is expected. Reduction of viscosity is an additional advantage which can be obtained during the chemical processing. This makes easy to apply bio diesel to diesel engines.

Table 1: Important physical properties (for fuels) of two common biodiesel feed stocks, petroleum diesel and biodiesel (B100)

Parameter	Refined Sunflower Oil	Refined Coconut oil	Petroleum Diesel (ASTM D 975 - 07)	Biodiesel (B 100*) (ASTM D 6751-09)
Density at 25 °C (kg L ⁻¹)	0.92	0.924	0.838	0.84-0.90
Kinematic Viscosity (mm ² /s or cSt at 40 °C)	29.9	27.6	1.9-4.1	3.5-5.0
Flash point (°C)	-	-	75	< 100
Smoke point (°C)	265	175	-	-
Boiling point (°C)	-	-	200- 350	315 - 356
Solidifying point (°C)	-	14 - 25	-50 - 10	-
Total Acid Number (mg KOH/g)	5.38	2.6	< 0.5	< 0.5

* The number following the 'B' stands for the percentage of biodiesel in the fuel



Figure 1: Biodiesel samples (from left to right: Jatropa, Castor, Rubber, Neem, Domba and Coconut) (Note- These samples were prepared by under a research of Dr C.S.Kalpage and Mr. T.M.M.K. Ranathunga) [4]

Even though biodiesel sounds more optimistic, plenty of serious challenges are associated with the implementation process. As the future directions in the field of biodiesel, it is necessary to pay more attention towards novel feed stocks in favour of increasing the efficiency of the production. There, it must be non edible, high oil bearing and rapid growing. In that hand, nowadays more attention is being paid towards algae as the bio mass source since it is non edible. Algae seem to have above

qualification and Table 2 shows the high oil to land ratio of algae than other crops. In addition to above qualification, it shows high nutrient absorption capacity for its growth. The nutrient can supply from water pollutant in aquatic system and hence the culture system can design as a water purification system. Use genetic technology to obtain modified algal species.

Table 2: Comparison of microalgae with other biodiesel feed stocks [5]

Plant source	Seed oil content (% oil by wt in dry biomass)	Oil yield (L oil/ha year)	Land use (m ² year/kg biodiesel)	Biodiesel productivity (kg biodiesel/ha year)
Corn/Maize (<i>Zea mays L.</i>)	44	172	66	152
Hemp (<i>Cannabis sativa L.</i>)	33	363	31	321
Soybean (<i>Glycine max L.</i>)	18	636	18	562
Jatropha (<i>Jatropha curcas L.</i>)	28	741	15	656
Camelina (<i>Camelina sativa L.</i>)	42	915	12	809
Canola/Rapeseed (<i>Brassica napus L.</i>)	41	974	12	862
Sunflower (<i>Helianthus annuus L.</i>)	40	1070	11	946
Castor (<i>Ricinus communis</i>)	48	1307	9	1156
Palm oil (<i>Elaeis guineensis</i>)	36	5366	2	4747
Microalgae (low oil content)	30	58,700	0.2	51,927
Microalgae (medium oil content)	50	97,800	0.1	86,515
Microalgae (high oil content)	70	136,900	0.1	121,104

Development of harvesting and oil extraction techniques is another research area which should be developed more in order to increase efficiency of bio diesel production chain. Catalytic conversion of extracted bio oil into bio diesel is another field which has to be paid immense research and development efforts. There, development of heterogeneous solid nano catalyst is one of interesting topic.

With all the theories and laboratory bench work, it is planned to implement the idea to pilot plant scale and finally to industrial scale in order to get final product economically. Finally, the concept of bio diesel definitely can meet petroleum diesel and it should meet petroleum diesel to overcome future energy crisis. Definitely it will become a sustainable and long term solution.

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WHAT IS GLYPHOSATE?

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Board of study in chemical sciences

Glyphosate is a phosphomethyl derivative of the amino acid glycine which is a white and odourless crystalline solid. It was invented in 1950 by a Swiss chemist, Dr. Henri Martin who worked for the small pharmaceutical company called Cilag. But it wasn't use in pharmaceutical applications because the compound had no biological activity in its inorganic division. After that glyphosate was synthesized and tested as a herbicide by Monsanto scientist Dr. Jhon Franze in May 1970. Finally this was introduced as Roundup® herbicide by Monsanto Company [1].

Mode of Action

Glyphosate inhibits the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), which present in fungi and bacteria, but not in animals. These enzymes catalyze the transfer of the enolpyruvyl moiety of phosphoenolpyruvate to shikimate-3-phosphate. This is a key step in the synthesis of aromatic amino acid hormones and other critical plant metabolites. The active site of the EPSPS enzyme in higher plants is very highly conserved. The mechanism of inhibition is also unique in that the binding site for glyphosate is reported to closely overlap with binding site of phospho-enolpyruvate [2].

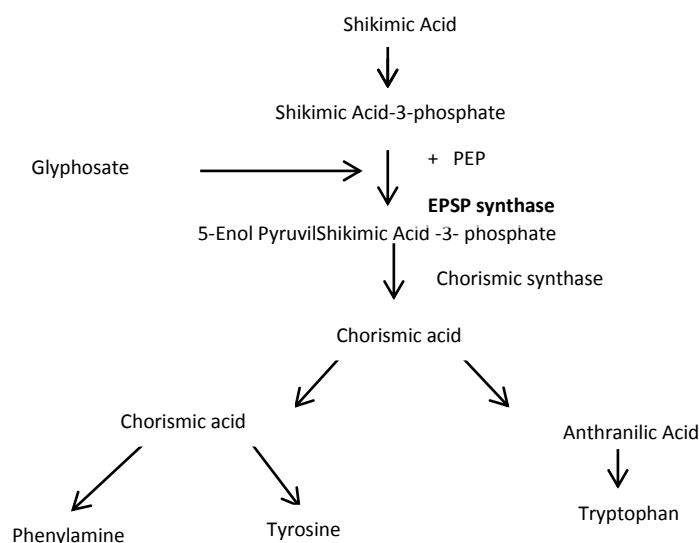


Figure 1: Mode of action of glyphosate [1]

Because of this mode of action glyphosate has become a very effective product. The translocating ability of growing meristematic tissue and inhibit an enzymic process present in plants can be used to control underground corms, rhizomes and other potential vegetative structures. Because of its unique properties, glyphosate was initially used to control perennial weeds on ditch bank in right of way and follow fields. However, utilization for main stream agriculture was limited because the crop was also killed by this chemical. Then the glyphosate is used for land preparation without tilling (non -till practice). Although it kills, it saves fuel, preserves soil from erosion and allows to better water permeation in the soil [1].

Degradation pathway

When glyphosate comes in to contact with soil, it can be rapidly bound to soil particles and become inactive. Unbound glyphosate can be degraded by bacteria. The half-life of glyphosate in soil ranges between 2 and 197 days. Adsorption and desorption of glyphosate depends on the type of the soil properties [3].

Metal chelating effect

Glyphosate has three functional groups (amine, carboxyl, and phosphate) that can form strong coordination bonds with metal ions to give bidentate and tridentate complexes. These complexes between metal ion and glyphosate have higher affinity than free glyphosate to the adsorbent. Therefore metal ions increase the adsorption of glyphosate on the soil on the other hand the presence of glyphosate decreased the adsorption of metal ion on the soil through changing solution pH and formation complexes of metal and glyphosate which increases the movement of soil water system. This will be potential threat to enhance the quality of the underground water [4, 5].

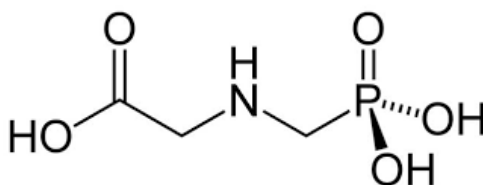


Figure 2: Structure of glyphosate [2]

Toxicity

Glyphosate is the active ingredient in herbicide formulations containing it. However, commercial glyphosate based formulations contain 1% - 41%. They generally consist of an aqueous mixture of the isopropyl ammine (IPA) salt of glyphosate, surfactant and various minor components including anti forming coloring agents inorganic ions to produce pH adjustment. As a result of that human poisoning with herbicide is not with active ingredient alone but with complex and variable mixtures. Therefore, it is difficult to separate the toxicity of glyphosate [1]. Experimental studies suggest that the toxicity of the surfactant, polyoxyethyleneamine(POEA) is greater than the toxicity of glyphosate alone [1]. But the residues of glyphosates, found in main foods including sugar, corn, soy and wheat can also give adverse effect to the gut bacteria, which can chronically affect to other mammals also [5].

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GALVANIZATION FOR CORROSION INHIBITION

I. N. Wickramathilaka

Board of Study of Chemical Sciences

Deterioration of metal surfaces in aggressive environment is defined as metal corrosion. The aggressive environment may be a liquid or a gas. Also, corrosion is a chemical or an electrochemical oxidation process, in which metal transfers electrons to the aggressive environment as follows.



Corrosion causes structural damage and it leads to many environmental problems. Therefore prevention of corrosion process is very important. Among corrosion prevention methods, galvanization is the most widely used technique. The process of applying a protective zinc coating to steel or iron is known as galvanization. There are three major processes for applying zinc to iron and steel, and those are hot dip-galvanizing, electro galvanizing and zinc spraying. Among these processes, most products are coated using hot-dip process.



Figure 1: Galvanized steel pipes



Figure 2: Galvanized roofing sheets

The term is derived via French from the name of Italian scientist Luigi Galvani. Originally, galvanization was referred to the administration of electric shocks. In the 19th century it was also termed as Faradism. The term galvanization has largely associated with zinc coating, to the exclusive of other metals. Galvanic paint, a precursor to hot-dip galvanization, was patented by Stanislas Sorel, of Paris, Franch in December, 1837. The earliest known example for galvanization of iron is found in 17th century which is the Indian armor in the Royal Armouries meuseum collection [1].

When choosing a corrosion prevention method, it must be an environmental friendly and a low cost method. Galvanization protects steel by acting as barrier to the moisture. Moisture acts as the electrolyte to metal corrosion process. This is a primary protection method for galvanized steel. Freshly exposed zinc form a thin zinc oxide layer. That zinc oxide forms zinc hydroxide when contact with water. Finally it becomes zinc carbonate by reacting with atmosphere carbon dioxide. It corrosion resistance is 7 to 10 times higher than that of iron.

The most important way of corrosion prevention of galvanization process is galvanical protection. It is also known as the cathodically protection [1]. Since zinc is more active than steel in the galvanic series, this process occurs. Variation of activity of some metals is shown below.

Mg > Zn > Al > Cd > Fe > Pb > Sn > Cu > Au



Increase the oxidation ability

Any one of these metals and alloys will theoretically corrode while protecting any other that is lower in the series as long as both form part of an electrical circuit and an electrolyte solution is present [2]. In practice, this means that a zinc coating will not be undercut by rusting steel, because the steel cannot corrode adjacent to the zinc coating. Coating thickness and conditions of exposure decide the service life of galvanized steel.

Acknowledgement

A special acknowledgement goes to supervisor Prof. Namal Priyantha, Department of Chemistry, University of Peradeniya.

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APPLICATIONS OF TRANSITION METAL MACROCYCLIC COMPLEXES

M. C. R. Peiris

Board of Study in Chemical Sciences

Applications of the transition metal macrocyclic complexes (TMMC) can be divided into several sections such as antibacterial drugs, catalysts, MRI scanning agents, antioxidants, ion transporters, radiopharmaceuticals etc, according to the way they use. Among these applications catalytic activity of these macrocyclic complexes has a major contribution to the green chemistry. Most of the TMMC are synthesized to act as the catalyst for various reasons, due to their high thermal stability, unusual structural, electronic and electrochemical properties. Some natural macrocyclic complexes have shown the capability of using as catalysts for many transformations such as vitamin B₁₂. Catalysis can be divided into a number of areas, depending on the substrate and the catalytic reaction. One of the prime areas of the initial effort in catalysis [1] has been the small molecule activation, such as O₂, NO₂, NO, H₂S and CO₂.

Transition metals such as Cu, Ni, V, and Fe also act as catalysts itself, but these metal catalysts have several drawbacks. These metals show the catalytic activity only when it is in 100% pure form, but the pure metals such as Pt are highly expensive. Another thing is, in higher potentials these metals can undergo oxidations that changes their surface properties. Dust, moisture, higher and lower temperatures will directly influence the catalytic activity of the metal. Many of these drawbacks can be eliminated by using these metals in the macrocyclic form. The common transition metals used in macrocyclic catalysts are Fe, Co, Ni, and Cu, and the macrocyclic ligands include chelating atoms N₄, N₂O₂, N₂S₂, O₄, and S₄. This can be further explained by considering the interaction between small molecules and a transition metal. Electron transition occurs first from small molecules such as oxygen and carbon dioxide into the empty d_z^2 orbital, forming a π bond, lowering the anti-bonding π orbital's and raising the energy of the d_{xz} and d_{yz} orbitals of the transition metals. This allows the electron transition from these filled orbital's to the anti-bonding π orbital, and resulting in catalytic activity.

These TMMC are also very popular in the medicinal field [2, 3] due to their resistivity towards the gram (-) and gram (+) bacteria [2], fungal growth and as the virus inhibitors. Few of the drugs such as VL-1, CoL-2, NiL-3 (Fig.1.) shows the inhibitor activity towards the microbial growth.

A number of macrocyclic chelators have been proposed as MRI contrast agents or as bifunctional agents for labeling antibodies and peptides with several radionuclides. Most frequently used paramagnetic metal in MRI contrast agent is Gadolinium [Gd (III)] ion, but free Gd (III) radionuclide are extremely toxic. Therefore it is required as they are administered to patients as chelates. When the metal ion is complexed, they become thermodynamically stable and kinetically inert (Fig. 2.).

Radiopharmaceuticals [4] are also emergent drugs in tumor therapy; new therapeutic radiopharmaceuticals have been recently prepared aiming to deliver large radiation doses to the diseased sites while sparing normal cells. For this macrocyclic complexes are used as the transporter of the radiopharmaceuticals.

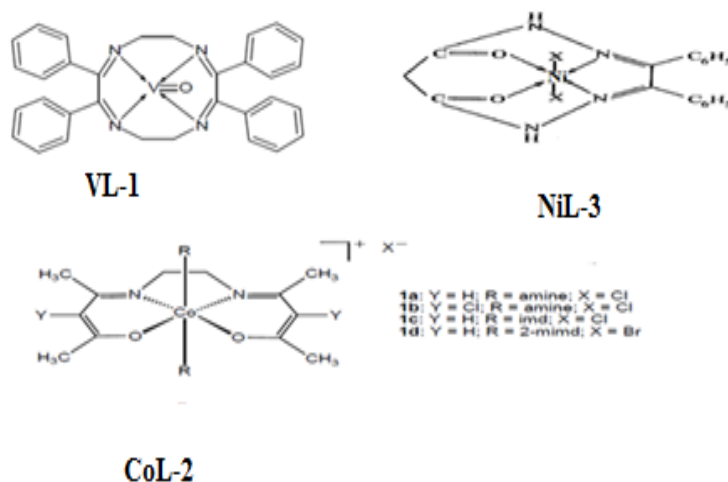


Figure 1: Antimicrobial drugs consist of transition metal atoms in the macrocycle. **VL-1**, shows antibacterial activities against *E.coli*(-), *S.aureus*(+) *M.luteus*(+) and *B.licheniformis* (+). **CoL-2**, Class of drugs was performed using model infected with Herpes Simplex Virus Type 1 (HSV-1) and all these complexes inhibited HSV-1. **NiL-3**, Shows a very good antifungal activity towards *Aspergillus flavus* and *A. niger*.

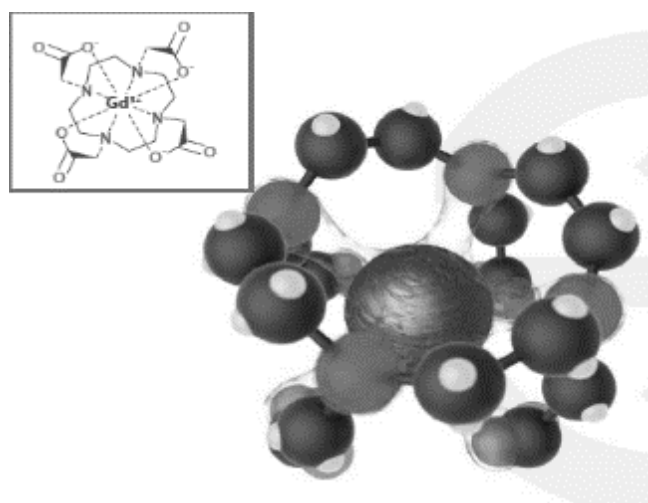


Figure 2: Metal complexes which are using for cell labeling and magnetic resonance imaging applications.

Macrocyclic complexes also act as ion transporters [5], especially cation transporters and those were one of the early focal points in macrocyclic chemistry, revolving primarily around the crown ethers and cryptands. Later efforts have been to provide switches to control the rates of cation transport. Further the transport capabilities of synthetic macrocycles is also used in analytical chemistry. Because of their selective complexation of a variety of cations, the crown ethers and related macrocycles have been widely used for separations and analyses. While transport efforts have largely involved metal cations, more recent developments have led to the use of macrocycles for transport of more complex molecules such as nucleosides. Not only these applications, macrocyclic complexes have many other applications too, such as antioxidant activity.

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NANO THINGS INTO MACROSCOPIC WORLD

W. M. N. M. B. Wanninayake

Board of Study in Chemical Sciences

Scientists believe that the Earth was formed around 2 billion years ago. It has gradually grown into this stage passing so many eras. In the mean time finding of fire, finding of wheel have directed the world to a new era which has been revolutionized by new findings. Another important finding was alchemy which was developed to modern chemistry today. Today, the world is headed towards nanotechnology which is the science in the 1 nm level. "There's Plenty of Room at the Bottom" was a lecture given by physicist Richard Feynman at an American Physical Society meeting at Caltech on December 29, 1959. Feynman considered the possibility of direct manipulation of individual atoms as a more powerful form of synthetic chemistry than those used at the time. The talk went unnoticed and it did not inspire the conceptual beginnings of the field. In the 1990s it was rediscovered and publicized as a seminal event in the field, probably to boost the history of nanotechnology with Feynman's reputation. However, this concept was used by the ancient people without knowing the science in it. For example, Roman people painted their church with different colours using different particle sizes of gold as the painting agent. This is only an example for the reduced particle size used by people in ancient times. Other examples are lotus effect, butterfly wing effect, geko's legs, etc.

The science behind the above mentioned nanotechnology scenarios were discovered by physicists and they verified that the characteristic features of the reduced particle size are different than the macroscopic size of the same material. This reduced size of particles has higher surface area (1000 time more) of the material into volume ratio. Also, when the particle size is reduced, it changes its chemical and physical properties due to the changes of the band gap of the material. When decreasing the particle size, it tends to increase the band gap of the material thus leading to different optical properties.

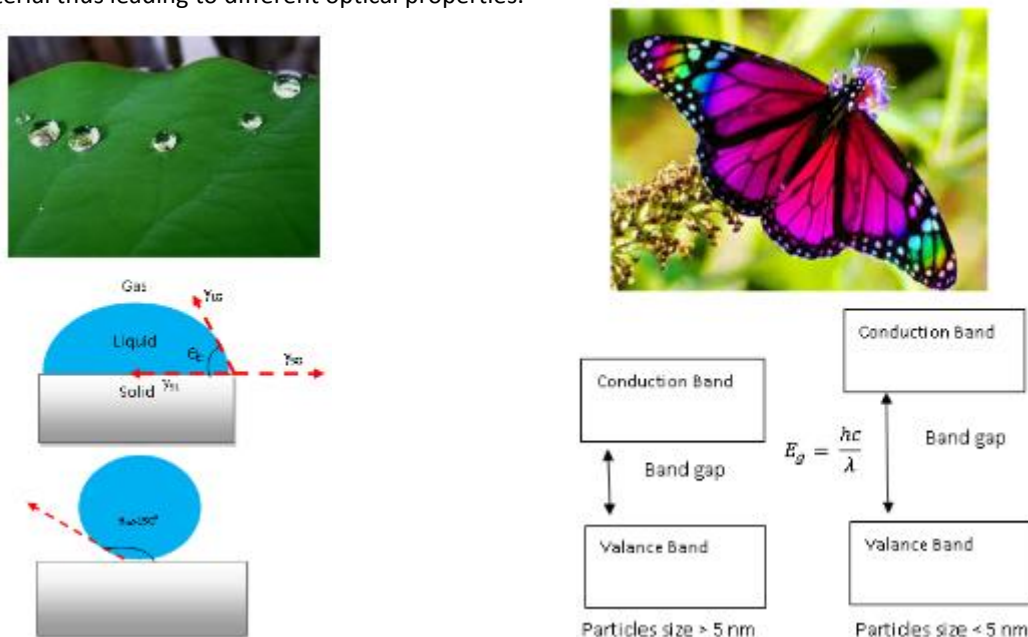


Figure 1: Lotus leaf and the theory behind ultrahydrophobosity and butterfly wings and theory behind colour variation

With time, scientists have been studying the preparation methods of nano particles via top-bottom or bottom-up approaches. Especially, chemists are interested in bottom-up approaches while physicists are involved in top-bottom approaches. However, both approaches have led to preparation of nano particles which are used for variety of applications such as, energy utilization using solar cells fields of dye-sensitized solar cells, thin film solar cells, organic polymer hybrid solar cells and energy storage batteries and fuel cells, water purification using various filtration techniques employed with nano particles, textile industry like self-cleaning, hydrophobic textiles, intelligent textiles, antibiotic and anti-fungal textiles, engineering applications such as molecular machine and robotics, nano electronic devices, ceramic manufactures with multiple properties like strength, porosity and hardness and medical applications such as bio-sensors, targeted drug delivery, cancer treatment, bone transplant and gene therapy.

Many organic and inorganic high band gaps insulating materials are involved in this field such as calcium carbonate, hydroxyapatite, carbon, calcium phosphates, aluminum oxide, silica and magnesium oxide [1] and high band gap semiconductor materials such as titanium dioxide, zinc oxide, cadmium sulfide and tin dioxide. Among them many of the semiconductor material nano particles are used for numerous applications such as gas sensors, heat mirrors, optoelectronic devices, electrode materials, Li-ion battery anodes, in catalysis and transparent electrodes for solar cell devices. Also there are variety of technique such as, sol-gel, precipitation, in-situ polymerization, freeze-drying, sputtering, microwave irradiation, anodic oxidation, thermal evaporation, thermal oxidation, physical vapour evaporation, solvo-thermal, carbothermal reduction, polymeric precursor, acid route and thin film by chemical vapor deposition involved in preparation of nano particles [2, 3].

Among them acid route and hydro-thermal processes are the simplest techniques in order to prepare nano particles. These are relatively inexpensive and require low energy. We have been studying the preparation of SnO₂ semiconductor nano particles in our Semiconductor Research Laboratory, Department of Physics, University of Peradeniya, and have employed both methods. We obtained 20 nm to 60 nm size particles which can be used for so called applications and we have already successfully employed them in dye-sensitized solar cell application [4]. We used relatively low temperature (around 100 °C to 250 °C) for hydro-thermal method in compared to acid route (around 500 °C to 800 °C). When the temperature was decreased, the particles size also decreased in both methods. Also, hollow nanosphere particles can also be obtained by varying the treatment period (time duration of the temperature supplying) in hydro-thermal methods. These findings can be used in the many different ways as SnO₂ is a high band gap semiconductor material.

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ARE THIN FILM SOLAR CELLS THE SOLUTION FOR ENERGY CRISIS?

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Board of Study in Chemical Sciences

Most of the energy we use comes from fossil fuels, such as coal, natural gas and crude oil which were created several hundreds of millions years by decaying plants and animals under high pressure and temperature at the earth crust. Consequently, these are called as non-renewable energy sources. As a result of rapid usage of these non-renewable energy sources, the world is suffering from impending death of fossil fuels and serious pollution by releasing carbon monoxide and sulfur dioxide due to the combustion of fossil fuels, which may result in acid rain and global warming. On the other hand, increasing energy demand has made a new crisis for scientists and researchers all over the world. As the report by the World Energy Outlook 2014 says "Global energy demand is set to grow by 37% by 2040", scientists have to find alternatives which are renewable, non-polluting, green and silent for the future energy demand. There are several alternative renewable energy sources such as hydro power, wind power, bio mass, geo thermal power and solar cells. Harvesting energy from the sun is more fascinating due to low cost, reliability, durability and stability.

The best possible answer to harvest solar energy is the SOLAR CELL. Solar cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. There are several types of solar cells called, multi-junction cells, single junction cells, crystalline Si cells, thin film cells. With the discovery of Silicon solar cell in 1954, research on solar cells has becoming attention-grabbing topic between scientists and researchers, more over among business holders. Consequently, the science and technology of solar cells (PV devices) and systems have undergone revolutionary developments from 1954. Today, the best single crystal Silicon solar cells have reached an efficiency of 24.7%, compared with the theoretical maximum value of 30% which are already in the market [1]. In 2014 the world has come to a remarkable mile-stone due to the cooperate work of Soitec and CEA-Leti, France, together with the Fraunhofer Institute for Solar Energy Systems ISE, Germany, by introducing a multi-junction solar cell; which converts 46% of the solar light into electrical energy in direct conversion of sunlight into electricity in the laboratory level [2]. But the problem of high cost involved with Silicon solar cells and multi-junction solar cells was recognized right from the beginning. So the next problem that has to be answered by the researchers is how to introduce low cost solar cells. It has also been recognized that cheaper solar cells can be produced only if cheaper, more delicate materials and lower cost technologies are utilized. The best possible answer given by scientists, researchers and engineers is thin film solar cells. For this answer not only low cost, there are several facts that have contributed such;

- (1) Small thickness required due to high absorption, small diffusion length & high recombination velocity
- (2) Materials economy, very low weight per unit power
- (3) Various simple & sophisticated deposition techniques
- (4) A variety of structures available : amorphous, polycrystalline, epitaxial
- (5) Different types of junctions possible –homo, hetero, Schottky
- (6) Tandem and multi junction cells possible
- (7) In-situ cell integration to form modules

Thin film photovoltaic devices take advantage of absorption of IR-VIS-IR light by semiconductors and convert light to power. Thin film technologies have a common device structure: *substrate, base electrode, absorber, depletion layer, top electrode, patterning steps for monolithic integration and encapsulation* but in a reverse order. Thin film CIGS (Copper Indium Gallium Selenide solar cells), cells and modules are 21.7% and 15.7% [3, 4] efficient and CdTe cells and modules are 20.4 % and 17% [5, 6] efficient. CdTe and CIGS PV modules have the potential to reach cost effective PV-generated electricity. They have slowly transitioned from the laboratory to the market place over the last decade.

The most nominated heterojunction structure of CdS/CdTe cells is with n-type cadmium sulfide (CdS) as a transparent window layer, and are generally fabricated in a superstrate configuration (Figure 1). This structure generally consists with the lattice mismatch of above 10% between CdTe and CdS. The formed heterojunction has an excellent electrical behaviour, leading to a high fill factor of 0.77 in produced solar cells [7]. Therefore, this structure is favoured by a variety of world-leading corporate. Recently, First Solar has launched one project to double its manufacturing capacity of CdS/CdTe solar cells from 1.5 GW at the beginning of 2011 to nearly 3 GW by the end of 2012 [8].

Currently, there are several challenges for the further development of CdS/ CdTe thin-film solar cells:

- (1) Short minority carrier lifetime due to the recombination of electron-hole pairs at the defect centres in CdTe layers and at the interface between CdS and CdTe.
- (2) Insufficient transparency of transparent conductive oxide (TCO) and CdS window layers.
- (3) Lack of good ohmic contact between CdTe layers and back contacts.
- (4) Possibility in doping p-type CdTe films in a stable way.

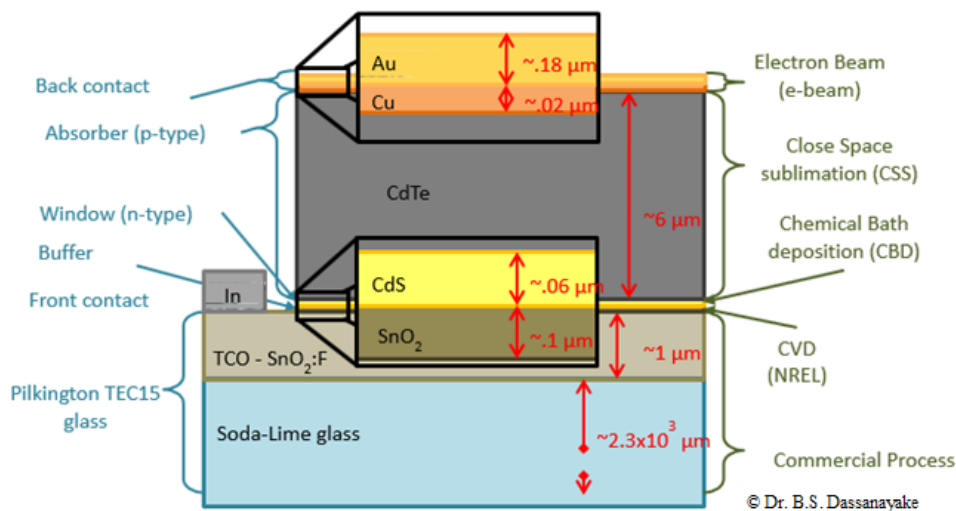


Figure 2: CdS/CdTe inorganic solar cell structure

The first three problems can be addressed with fabrication technology, structural design, and choice of back contact, respectively. Consequently, numerous ways have been employed to synthesize group II-VI thin films by various researchers in order to address the above aspects: Radio frequency sputtering (R. F. Sputtering), close-spaced sublimation (CSS), and chemical bath deposition (CBD) for CdS preparation, while electrodeposition (ED), screen printing (SP), and CSS for CdTe thin-film formation [9].

The second methodology to improve efficiency is the modification on the structure of CdS/CdTe solar cells. In here there are two methods: nanostructure and tandem cells. Nanostructures are considered to be the most encouraging method to achieve high efficiency and low cost from structural phase [10]. By substituting a nanopillar instead of a planar CdS layer, this provides excellent transparency of CdS layer, if the size of nanopillars is much smaller than the wavelength of visible light. Looking the other way, light absorption is boosted simultaneously due to the quantum confinement effect. In addition, this approach also offers more flexibility, since the optical gap can be altered by size variation of nanopillars. The other popular structural explanation to increasing efficiency is tandem cells. Tandem solar cells can either be individual cells or connected in series. Series connected cells are simpler to fabricate, but the current is the same through each cell so this constrains the band gaps that can be used [11]. Tandem solar cells can be illuminated from both sides and more importantly, long-term stability can be improved.

The third aspect is to find a perfect back contact. Since, p-type CdTe has high electron affinity, the Fermi level pinning would be formed between the absorption layer and the metal layer. Consequently, a reverse-biased potential would be formed at the CdTe-metal interface to limit the holes' transport and would enormously reduce the cells' efficiency. Hence, an ohmic contact is essential. So several techniques have been discovered to suppress the large Schottky barrier and reduce the contact resistance at the CdTe-metal interface. One interesting attempt was ZnTe as a buffer layer between the CdTe layer and the Cu and Au back contact as in Figure 1.

According to the discussion made here, it is still believed that CdS/CdTe solar cell will be a crucial runner for global low-cost solar cells market in future as the best answer for the world energy crisis. By understanding this crisis and the imperativeness of the thin film solar cell, Department of Physics, University of Peradeniya has started working on low cost thin film solar cells specially focusing on extremely vigorous CdS/ CdTe systems with tremendous potential expertise in the field and working closely with University of Illinois at Chicago and Sivanathan laboratories at USA.

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IT AND STATISTICS

GEOGRAPHIC OFFENDER PROFILING

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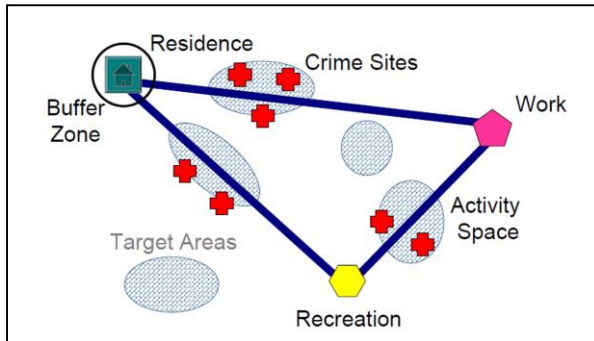


Figure 1: Brantingham's Crime Site Selection

Geographic offender profiling is used to predict offender related parameters using their information about location and timing of offences. There are several ways that Geographic profiling can be used for offender profiling in crime investigation. One of the most frequently used applications of geographic profiling is to predict criminal's most probable place of residence. This is performed with the help of where they are likely to live; what sort of knowledge they have of a particular area; understanding the link between an offend and a location such as why certain places attract more crimes than others; why, even in 'high crime' neighborhoods, some addresses are repeatedly victimized and some are left alone. Therefore, geographic profiling is well suited for serial offences committed in the areas of murder, bombing, arson, rape, child abduction, sexual homicide, credit card fraud, property theft, etc. The results filtered from Geographic profiling can then be used to let police officers protect more vulnerable areas. This method has been first developed by Kim Rossmo as his Ph.D dissertation at Simon Fraser University based on the work of Brantingham, making an assumption that crime locations are not random [1].

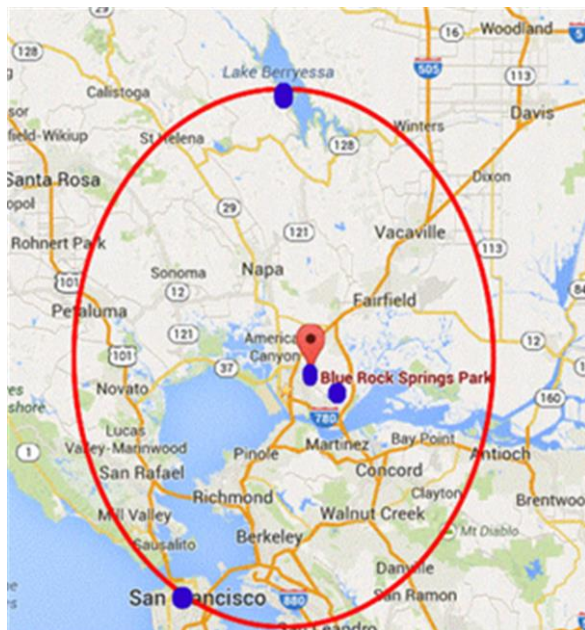


Figure 2: Canter and Larkin model of 'circle theory of environmental range'

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Several principles such as "least effort", "routine activity", "distance decay" and "rational choice" have been used in taking the decisions upon geographic profiling. Many criminals have their own territory where they conduct crimes. Most of the time, these criminals tend to stick within the area of which they have most of their power of. This is called the principle of "least effort". It has been observed that the inexperienced offenders move less than the experienced offenders. But in the case of bank robbers and burglars, it is a bit different because they move farther than the other criminals to accomplish their goal. In "routine activity" principle, the victims are connected to some routine activity of suspects. For example, both suspect and the victim might have been travelling in the same bus, or maybe they have been having their meals in the

same restaurant. “Routine activity” in geographic profiling assumes that the criminals plan their crimes during their daily routine. The principle of “distance decay” is related to “least effort” in such a way that the criminals making less effort to move farther from their living area. This may cause crime investigators capturing the criminals less probable when they investigate for criminal residences further away from the scene of crime [1]. “Rational choice” refers to the fact that the humans making their decisions rationally or either in the narrow sense of rational self-interest. The principle of “Rational choice”, in the sense of geographic profiling is applicable towards criminals preferring same areal pattern committing their crimes [2]. Brantingham has proposed a crime site selection model [3] based on these principles as depicted in Fig. 1.



Figure 3: The crime series of Levi Bellfield

there is a 30 minute delay after the Blue Rock Springs attack. This has made the investigators to assume assuming that he would have lived nearby [4].

Another serial crime scene where it has exhibited “least effort”, “distance decay” is the crime series of Levi Bellfield⁵ who was convicted of murdering three young women and trying to kill another which has been depicted in Fig. 3 [5]. Operation of Lynx [6] is another example where geographical profiling has been used in order to predict the criminal’s residence. Fig. 4 shows a probabilistic map of probabilities that the criminals home can lie in. The places with the highest probability have been colored in orange by directing the police as where

Many geographic profiling models have been proposed. Canter and Larkin (1993) have proposed a model called ‘circle theory of environmental range’ based on the principles of geographic profiling. This model suggests a circle to be drawn around the crime scenes. One of the actual situations where this method has been applied to resolve a crime scene is the incident of the Zodiac Killer [4] where the criminal has conducted a series of crimes. Fig. 2 shows how the ‘circle theory of environmental range’ has been used to narrow down the area of the killer’s residence. It can be assumed that the killer’s residence should be lying somewhere within the circle. According to the principle of “least effort” and “distance decay”, we can assume that a killer normally starts his crimes closer to his residence. Since, San Francisco crime was the killer’s last crime; it should have been the farthest from his residence. In further analysis of the investigation process, the investigators have observed that

to focus their research [6]. Several computer applications have been developed to assist the analysis of geographic profiling. The Criminal Geographic Targeting Model built in to the “Rigel software” [7] includes mathematical models of known offending movement patterns and hunting behavior, journey to crime distances and includes a method to calculate the relationship between sets of crime locations and offender residence

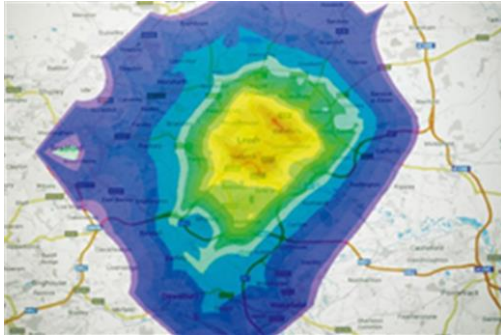


Figure 4: Operation of Lynx

[7]. Imagine a map with an overlaying grid of pixels. Let $S_{i,j}$ denotes the pixel on i^{th} row and j^{th} column located at the point with coordinates (X_i, Y_j) . The following function gives the probability $(P_{i,j})$ of the position of the serial criminal residing within a specific point.

$$P_{i,j} = k \sum_{n=1}^{\text{total crimes}} \left[\frac{\phi_{ij}}{(|X_i - x_n| + |Y_j - y_n|)^f} + \frac{(1 - \phi_{ij})B^{g-f}}{(2B - |X_i - x_n| - |Y_j - y_n|)^g} \right]$$

Where $\phi_{ij} = \begin{cases} 1; & (|X_i - x_n| + |Y_j - y_n|) > B \\ 0; & \text{otherwise} \end{cases}$

Here, the summation is over past crimes located at coordinates (x_n, y_n) . ϕ_{ij} is a characteristic function that returns 0 when a point (X_i, Y_j) is an element of the buffer zone B which is defined to be the neighborhood of a criminal residence that is swept out by a radius of B from its center. $|X_i - x_n| + |Y_j - y_n|$ is the Manhattan distance between a point (X_i, Y_j) and the n^{th} crime site (x_n, y_n) [8].

Conclusion

Geographic offender profiling is mainly used as a tool in the crime investigation process to either to locate an offender's residence or to use special patterns to profile a particular offender. But the results of the findings can be subjected to contamination due to the cognitive biases of the offenders as they can have multiple spatial patterns of operandi.

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ICT SIMPLIFIES HOMECARE

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¹Board of Study in Statistics and Computer Science

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Homecare is a new approach to monitor patients and their daily routines. With the competitive and complex life styles, looking after the elderly and the feeble has become an obstacle for many. To ease these circumstances homecare has become a popular choice. Sophisticated digital medical tools and communication protocols have been developed and introduced to the industry to further enhance the level of care received by the needy [1]. Yet, the prevailing situation and the medical condition of the patient are not easily accessible to their immediate relatives, such as children (Figure 1).

Sophisticated Homecare is needed when...

- The relatives would be worried to know the immediate conditions of a person having care.
- The person is lonely at home.
- It is difficult for a relative to reach the person.

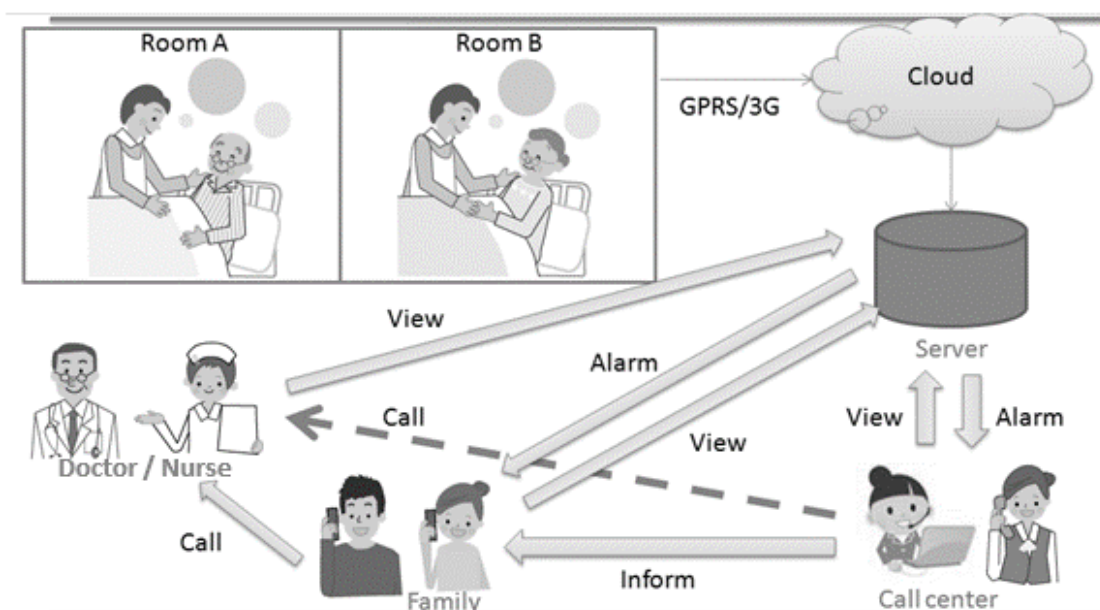


Figure 1: System Overview

Main features of the System

A sensor called Mat Sensor, attached (Figure 2) to the mattress or bed-sheet that a person is lying on, measures a few vital signs such as,

- Heart rate
- Respiratory rate
- Body movement



Figure 2: Transponder



Figure 3: Mat Sensor

A transponder (Figure 3) collects the sensor signals and uploads to a server in every pre-configured time interval. The patient is provided with a mobile computer such as a tablet PC, with a user-friendly software application (Figure 4 and Figure 5) to update their daily routine. In the case of a patient being incapable of performing these updates, a medical assistant will visit the patient to update the system. The collected information is stored and managed by a central database. The relatives of the patient who are authorized to access the information are registered at the digital call center.



Figure 4: Graphical View of Vital Signs



Figure 5: Vital Record Mobile Application

When a registered relative places a call to the call center, the information of the patient is automatically displayed to an agent who receives the call. Thus, homecare, supported by advanced vital sign sensors with computer software and call center hybrid solution simplifies the patient monitoring effectively and economically.

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MODERN TECHNOLOGY IN SPORTS

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From the beginning of the human civilization “sports” has become an important part of human life. It is also developing continuously with the evolution of Human Civilization with the blessings of modern technology. In modern era every aspect of sports enhanced with the use of new technology, especially, limitations of monitoring process carried out by naked eye. It is also realized that, use of these technologies would enable proper ranking of a sportsman or a team according to international standards. As examples, “Hawkeye technology” use in Cricket for ranking ball delivering speed and “Swing angle technology” that is used for ranking the best technical batsman. In football and rugby, monitoring systems are used for evaluate running speed distance of individual athletes for ranking of best performance team [1].

Even though, the use of modern technology in sports is in sophisticated level in international context, Sri Lanka yet far behind in sports technology other than in cricket (Figure 4). However, other sports like weightlifting, high jump, long jump and hurdles are holding higher popularity in Sri Lanka, but those events rarely use relevant technologies due to their high maintenance cost.

When not using advanced technology in sports, Sri Lanka lost competitive advantage against other countries used such technology to improve skills of athletes. As an example, Technology of Global Positioning System (GPS) technology is used in GPS-R to measure the running path and ball throwing path in Rugby and this technology also used in Cycling, Marathon and etc. A special body kit is used in this method, and the technique tends to be of very expensive. V-scope is a popular technique that is used to evaluate the performance of weightlifters. The type of data that can be acquired for a snatch, see Figure 1, using the v-scope [2] can be seen in Figure 2. This information is very important to prevent technical faults of an athlete. Even though these technologies are much beneficial of improving the competitiveness of the sportsman in many events, Sri Lanka yet to implement them because of the higher cost should be incurred.

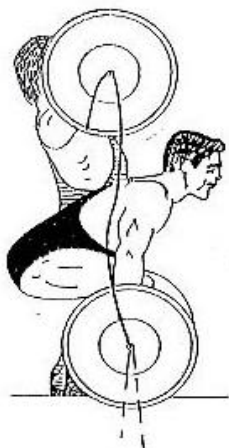


Figure 1: Weightlifting Snatch

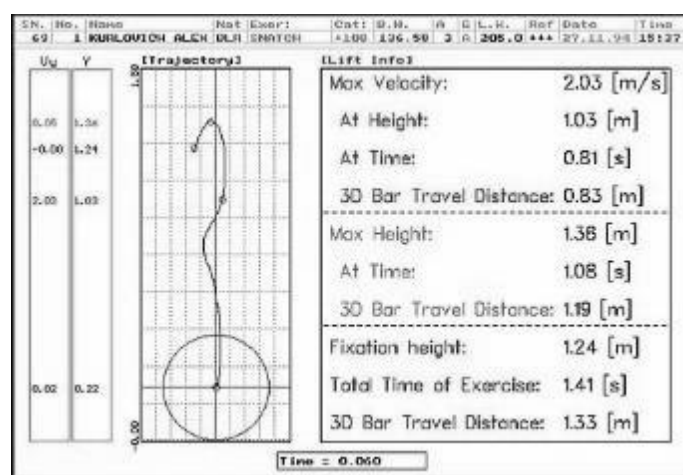


Figure 2: V-Scope Trajectory and data table

Sport motion tracking is another important technology that is commonly used in. Its work is tracking weightlifting bar movement and Sports athlete's body moments. This is achieved by obtaining the points of interest of the bar or athlete's body and is subjected to a particular motion in two consecutive frames. Continuation of finding the correspondence of the next two consecutive frames, while using the previous result as a new object, makes up the tracking process.

Speed motion tracking systems use video sequences to estimate object motion. Some of the most challenging tracking applications involve speed moving objects like weightlifting bar movement. In particular, human motion capture is widely used in visual effects and scene understanding applications [3]. Estimates of tennis ball tracking are also very fast movement (Figure 3). High speed video (60 to 300fps) cameras used to capture these Speed Motions.

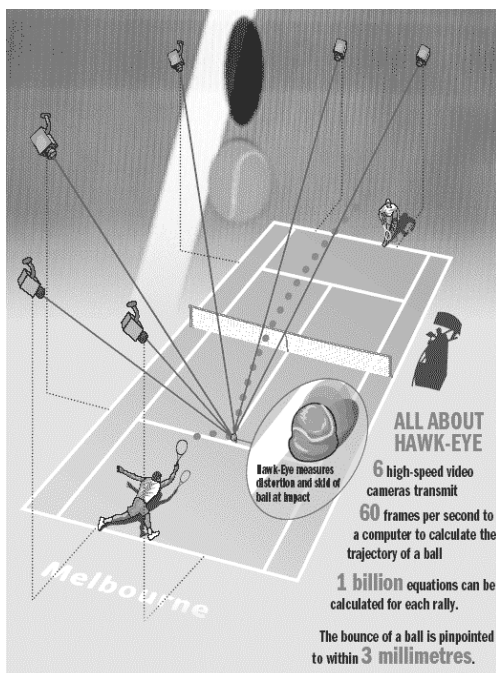


Figure 3: HAWK-EYE using in Tennis

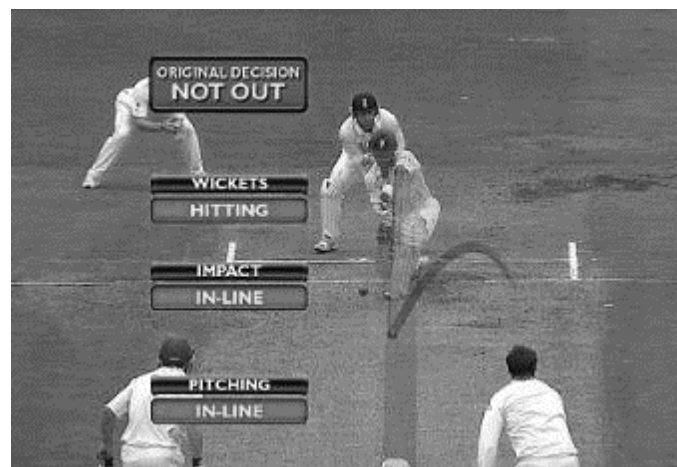


Figure 4: HAWK-EYE using Cricket

Possessing HAWK-EYE, V-Scope and GPS-R like techniques is very expensive for developing countries. However, for Cricket it is possible to obtain the service from counties like Australia. But for other sports such as weight lifting and rugby, it is not feasible due to the cost incurred. A promising solution is using image processing techniques to track the trajectory and motion in sports due to its low cost.

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KEY STEPS IN THE RESEARCH PROCESS

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Board of Study in Statistics and Computer Sciences

There are several important aspects to research methodology. This is a summary of the key concepts in scientific research and an attempt to erase some common misconceptions in science. At last, I conclude and generalize it to the real world.

Formulating a Research Problem

An essential early step in the process of research is to find a research problem. This helps focus the research process so that they can draw conclusions reflecting the real world in the best possible way. The nature of your problem will, in its turn, influence the form of your research.

Hypothesis

In research, a hypothesis is a suggested explanation of a phenomenon. A null hypothesis is a hypothesis which a researcher tries to disprove [1]. Normally, the null hypothesis represents the current view/explanation of an aspect of the world that the researcher wants to challenge.

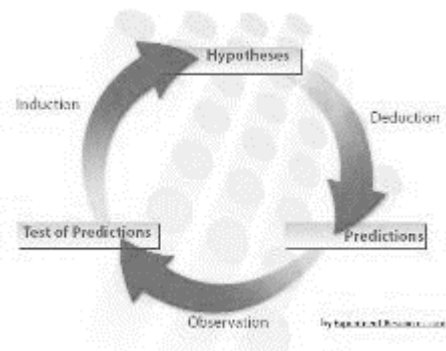
A scientific theory or law represents an hypothesis, or a group of related hypotheses, which has been confirmed through repeated experimental tests.

The word model is reserved for situations when it is known that the hypothesis has at least limited validity.

Variables

A variable is something that changes. It changes according to different factors. Researchers are often seeking to measure variables. An example, temperature is a variable. The temperature varies according to other variable and factors. In research, you typically define variables according to what you're measuring. There are many types of variables, discrete, continues, binary, confounding etc.

For example, Confounding variables obscure the effects of another variable. If one elementary reading teacher used a phonics textbook in her class and another instructor used a whole language textbook in his class, and students in the two classes were given achievement tests to see how well they read, the independent variables (teacher effectiveness and textbooks) would be confounded. There is no way to determine if differences in reading between the two classes were caused by either or both of the independent variable.



Choosing the Research Method

The selection of the research method is crucial for what conclusions you can make about a phenomenon [1]. It affects what you can say about the cause and factors influencing the phenomenon. It is also important to choose a research method which is within the limits of what the researcher can do.

Choosing the Measurement

Choosing scientific measurements are also crucial for getting the correct conclusion. Some measurements might not reflect the real world, because they do not measure the phenomenon as it should.

Results

Significance Test

To test a hypothesis, a quantitative research uses significance tests to determine which hypothesis is true. A significance test can show whether the null hypothesis is more likely to be true than the research hypothesis. The t-test (also called the Student's T-Test) is one of the many statistical significance tests, which compares two supposedly equal sets of data to see if they really are alike or not. The t-test helps the researcher to conclude whether a hypothesis is supported or not.

Drawing Conclusions

Drawing a conclusion is based on several factors of the research process, not just because the researcher got the expected result. It has to be based on the validity and reliability of the measurement; how good the measurement was to reflect the real world and what more could have affected the results.

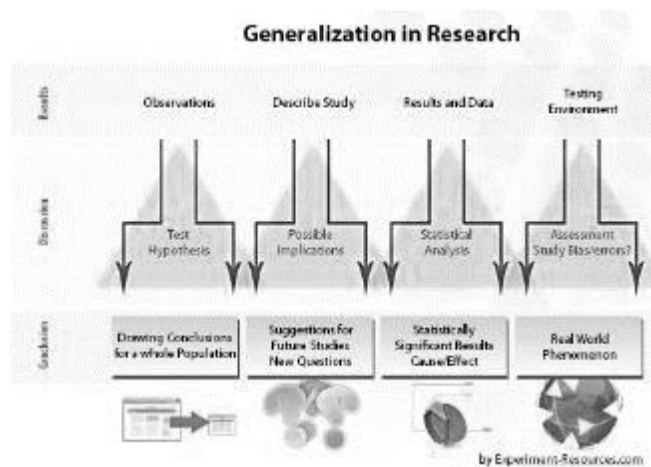
The observations are often referred to as 'empirical evidence' and the logic/thinking leads to the conclusions. Errors of the observations may stem from measurement-problems, misinterpretations, unlikely random events etc.

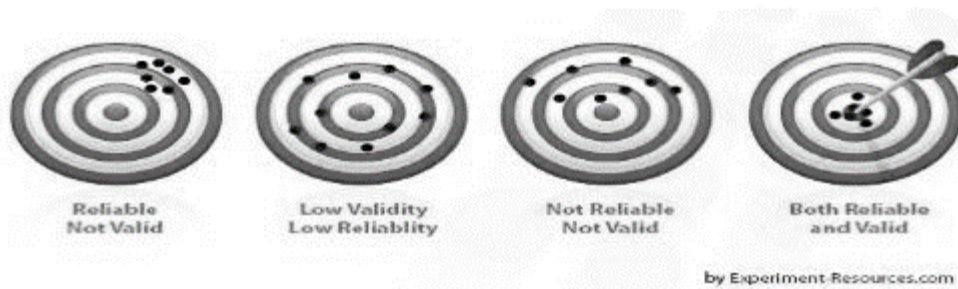
Generalization

Generalization is to which extent the research and the conclusions of the research apply to the real world. It is not always so that good research will reflect the real world, since we can only measure a small portion of the population at a time.

Validity and Reliability

Validity refers to what degree the research reflects the given research problem, while Reliability refers to how consistent a set of measurements are [2].





A definition of reliability may be "Yielding the same or compatible results in different clinical experiments or statistical trials" (the free dictionary). Research methodology lacking reliability cannot be trusted. Replication studies are a way to test reliability. Both validity and reliability are important aspects of the research methodology to get better explanations of the world.

Errors in Research

Logically, there are two types of errors when drawing conclusions in research:

Type 1 error: reject the null hypothesis when it is true

Type 2 error: fail to reject null hypothesis when it is false

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OVERFITTING

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Board of Study in Statistics and Computer Science

Using models to capture relationships in data is trending in many disciplines. Samples were used to identify the hidden characteristics in a population. Having few observations in a sample and many features describes patterns that are only available in the sample itself, rather in population. This is a situation a model has been overfitted to the sample data (training data).

Overfitting is a common problem occurred in creating models for training data. This may be due to using a large number of features or applying an unnecessary large polynomial model. Overfitting can be a serious problem since it seems to have a good fit on training data and result erroneous output for new data [1].

For example in a regression model that identifies the relationship between a dependant variable and predicting variables, it is possible to find a model that best fit to the given dataset (the training dataset) and then predict the value for the dependant variable for a given set of independent variables. Let's have a look at three different models to understand the concept.

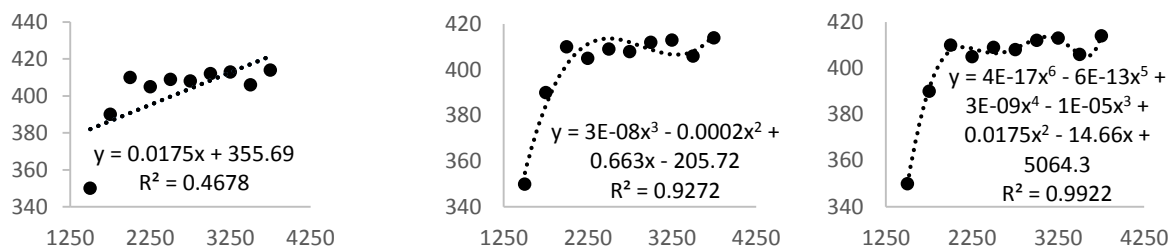


Figure 1: Three regression models for same data. (a) Linear model doesn't have a good fit for the data. (b) Third order polynomial model has a good fit for the data. (c) Sixth order polynomial model with extremely good fit compare to (b).

There are three different models (a linear, a third order polynomial and a sixth order polynomial respectively) has been fit to the same dataset. The equation of the model and R^2 (coefficient of determination) are also displayed on each plot. By considering the R^2 we can see that the sixth order polynomial model has the best fit to the data. It can be seen that linear model is underfitted to the dataset. However, the third order polynomial model also has a better fit to the dataset than linear fit. Even though the measure of R^2 provides the goodness of fit of the model to the data at present it doesn't provides how well the model will perform on data not presented [2].

Assume a classification problem that classifies two different classes of data. The following images show three different classifiers for the same data set.

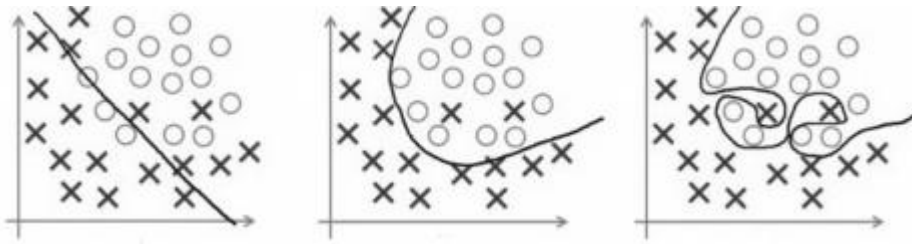


Figure 2: Classification models for a two classes of data (courtesy of <https://affineanalytics.wordpress.com>). (a) Classifier is a linear model. However it doesn't seem to classify well. (b) Classifier is a non-linear model. Even though two data points have been incorrectly classified the model has good performance. (c) Classifier is a higher order polynomial model. The model classifies all data points correctly. However this may not perform well on a new data point.

In the problem of overfitting, model may fit to the data at present but fail to generalize the model to new data. Therefore model validation algorithms can be used to find the best model explains the data.

Having multiple features may cause overfitting. Therefore, it is recommended to drop the features that don't provide much information. Using a small sample tends to return biased model which can't generalize information of population [3]. In the case of having large number of features for a dataset, it is possible to reduce number of features by selecting features manually for the model. Or, it is possible to use regularization techniques so that all features are included to the model and the magnitude of them is reduced. Therefore, each feature contributes a bit to the model. So the effect of certain features to the dependant variable is minimized [3]. This is done by adding a penalty for parameters (except the interception). But regularization can cause underfitting when penalty for parameters are extremely large. In extreme cases, the effect of all features equal to zero, so that, only the interception will contribute in the model [4]. If we consider the linear regression example and try to penalize the parameters of the sixth order polynomial model with a high value, end result will be a horizontal line ($y = 5064.3$).

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SOCIAL SCIENCES AND HUMANITIES

IT MAKES YOU THINK TWICE.....

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Alcohol is a psychoactive substance that is used in various cultures and countries with the dependence of diverse factors. Social and economics tragedies are involved with harmful use of alcohol [1]. *Lord Buddha* understood the dangerous effects of alcohol use on human beings. Therefore, *Lord Buddha* advised human



beings to refrain from drinking alcohol. According to the *lord Buddha's* teaching, it's said that, "***Surāmerayamajjapamādaṭṭhānā veramaṇī sikkhāpadaṃ samādiyāmi***" and its mean that "**I refrain from drinking alcohols**".

3.3 million deaths of every year results due to the use of alcohols while this represents 5.9% of all deaths. Also, 25% of deaths of 20-29 age group are mainly due to the alcoholic disaster. The latest relationships have been established between harmful drinking and incidence of infectious diseases such as tuberculosis as well as the course of HIV/AIDS [2]. There are several factors effecting to the alcohol consumption such as, environmental factors include economic development, culture, availability of alcohol, and the comprehensiveness and levels of implementation and enforcement of alcohol policies [3].

Categories of alcohols

General categorization of alcoholic beverages with their alcoholic percentages is mentioned below [4],

- Beer: 4-6%
- Wine: 7-15%
- Champagne: 8-14%
- Grain alcohol: 95-97.5%
- Malt liquor: 5-8%
- Wine coolers: 5-10%
- Hard liquor (Distilled spirits - vodka, rum, whiskey, etc.): 40-95%

Effect of alcohol on the human health

Alcohol is absorbed in to bloodstream and distributed throughout the body. This alcohol exits in your urine and your breath. If you eat food which has high fat while you are drinking alcohol it will cause slow absorption of your body. Alcohols act as a stimulant at lower level doses. It induces feelings of euphoria and talkativeness. Those are the primary actions shown by persons who drunk alcohols. But drinking too much alcohol at one session can lead to drowsiness, respiratory depression (where breathing becomes slow, shallow or stops entirely), coma or even death. After a drink is swallowed, the alcohol is rapidly absorbed into the blood (20% through the stomach and 80% percent through the small intestine), and the effects are felt within 5 to 10 minutes after drinking. It usually peaks in the blood after 30 to 90 minutes, and thus is carried through all the organs of the body [5].

Central Nervous System

Alcohols travel through all the blood streams and quickly reaches to many parts of the body such as, brain and other parts of the central nervous system. It can affect coordination, interfering with balance and the ability to walk. Several alcoholism can progress to permanent brain damage, causing dementia. Further it can damage to salivary glands and irritate the mouth and tongue, leading to gum disease, tooth decay, and even tooth losses as visible health effect through nervous system.

Circulatory System

Even a small amount of alcohol can caused trouble to heart if you are a chronic drinker. Heart damage for women has a higher risk than men. Therefore, women should pay their attention on this tragedy. Circulatory system is one of the complicated systems and effects mentioned below may occur [6]. Poisoning of the heart muscle cells (cardiomyopathy) irregular heartbeat (arrhythmia) high blood pressure, stroke, heart attack and heart failure.

Immune System

Fighting off viruses, germs, and all types of illness are caused due to alcohol abuse. Chronic alcohol use increases the risk of many forms of cancer.



Drinking alcohols is up to you. But it affects to everyone around you including your family and friends.

Think twice before use alcohols.....

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ENVIRONMENTAL SCIENCE

SELENIUM AND HUMAN HEALTH

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Selenium (Se) is a naturally occurring, non-metallic trace element identified as an essential nutrient for human and animal health. It is unevenly distributed on the surface of the earth and consequently the concentration in different geo-ecosystems varies widely, forming seleniferous and seleno-deficient geo-ecosystems. This uneven distribution and low bioavailability of selenium likely to affect the health of both humans and animals through the food chain. Therefore the selenium in the geo-environment is of special importance, particularly to the developing countries of the tropical belt where there appears to be an apparent association with some diseases [1].

The intake of selenium varies widely, ranging from deficient to toxic levels. An intake of less than 11 $\mu\text{g/g}$ per day is considered deficient, while a dose in excess of 900 $\mu\text{g/g}$ per day is considered toxic to human health [2]. Protein energy malnutrition, haemolytic anaemia, cardiomyopathy, hypertension, ischemic heart disease, alcoholic cirrhosis, cystic fibrosis, infertility, cancer, arthritis, muscular dystrophy, multiple sclerosis and osteoarthropathy/ Kaschin-Beck disease (Fig. 1) are some diseases associated with low intake [3, 4] whereas garlic breath, hair and nail loss, skin and nervous system disorders, poor dental health and paralysis associate with toxic levels. Recommended average selenium intake is 60 μg per day for men and 53 μg per day for women [5].

Nutritional functions of selenium are attained by 25 selenoproteins and many of them are important to human health as most of them are important enzymes. Selenium plays an important part of the antioxidant enzyme, glutathione peroxidase (GSH-PX) that protects cells against the effects of free radicals that are produced during normal oxygen metabolism. Recent studies from United States (US Third National Health and Nutrition Examination Survey, Women's Health and Aging Study) and France (Epidemiology of Vascular Ageing Study) shows that high selenium status associate with low overall mortality as well.

Selenium also has the immunostimulant effect which helps the normal functioning of the immune system. It can enhance the proliferation of activated T cells, increase cytotoxic lymphocyte-mediated tumour cyto-toxicity and killer cell activity. A study from UK confirms that persons supplemented with selenium and injected with attenuated poliovirus can defend themselves against the virus more rapidly.



Figure 1: Patients diagnosed with Kaschin-Beck Disease in China

As human thyroid gland has the highest selenium concentration of all the other tissues, recently it has been suggested that selenium deficiency may be a driving factor in the onset of Iodine Deficiency Disorders (IDD). Selenium deficiency can inhibit the function of selenoenzyme, type 1 iodothyronine deiodinase (IDI) which governs the generation of active thyroid hormone tri-iodothyronine (T3), from inactive prohormone thyroxine (T4) and can adversely affect the thyroid hormone metabolism [6].

Occurrence and progression of some viral infections are closely linked with selenium deficiency and under deficient condition; harmless viruses also can be virulent. As example selenium is crucial nutrient for HIV infected individuals and selenium deficient patients are 20% more likely to die due to HIV than the others [7]. Some researchers have also proved that viruses may have the ability to get selenium from the host to produce viral selenoproteins and reduce the effect of host's immune response [8].

Selenium is also essential nutrient for brain function where its deficiency can cause for irreversible brain injury. Researchers have found that there is a strong relationship with serum selenium level and seizures, Parkinson's disease, coordination and cognitive decline. Epidemiological studies have revealed an inverse relation between selenium level and cancer mortality. Higher cancer risks are possible in areas where the dietary intake of selenium is low. Generally lung, colorectal, thyroid and prostate cancers are associated with selenium deficiency.

In Sri Lankan context, it has been identified that significant proportions of the Sri Lankan female population may be selenium deficient [9]. According to World Health Organization (WHO), low serum selenium levels have been recorded in people with CKDu in Sri Lanka [10]. Selenium deficiency may be a contributory factor in increasing the susceptibility of the kidneys to oxidative damage.

The effect of selenium on human health is complex and further research is required to identify the benefits and also the possible risk. In Sri Lanka except Fordyce et al., (2000) no detail studies have been considered selenium and its behavior in the geo-environment of Sri Lanka. Therefore, identification of the availability of selenium and dietary intake through the food chain in local environment is essential requirement for the benefit of both humans and animals. Currently a comprehensive research project is being carried out to investigate the selenium in the geo-environment of Sri Lanka in which Se levels in water, soil, rice and plants are investigating. The project is funded by the National Research Council.

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WE ARE RUNNING OUT OF TIME

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We will think about our day to day life style. Every day, every morning, everybody not even human bodies; start their new day. In every single second, many factories such as transportations systems consume large amount of fossil fuel emitting green house gasses and other by products. As we all aware that greenhouse gases cause global warming whereas the by-products cause global dimming.

Let me see what global dimming is. In detail, it can be simply defined as the; due to the usage of fossil fuel, greenhouse gases, as well as other by-products are formed. These by-products such as sulphur dioxide, soot, and ash are also pollutants. Due to the increased presence of aerosol particles in the atmosphere, caused by human action, the properties of clouds can be changed [1]. As we all know, when water droplets are seeded by air-borne particles, such as pollen, clouds are formed. Solar energy is absorbed, and sunlight is reflected back into the space by aerosols and other particulates, which are associated with the clouds. The pollutants can also become nuclei for cloud, and water droplets that coalesce around the particles. The pollution can create a greater number of smaller droplets in clouds which can be rapidly increased and extremely more particulates are formed. More reflective clouds are made by these created smaller droplets, so that more incoming sunlight is reflected back into space and less reaches the Earth's surface [2]. This same effect can be seen, where the radiation reflect from the surface of the earth, trapping it in the lower atmosphere. This resulting reduction of heat reaching the earth is known as Global Dimming. Both heat radiated from the Earth and heat from the sun, are intercepted by the clouds. The natures of the clouds are not only complex but also varied with time, location, and altitude.

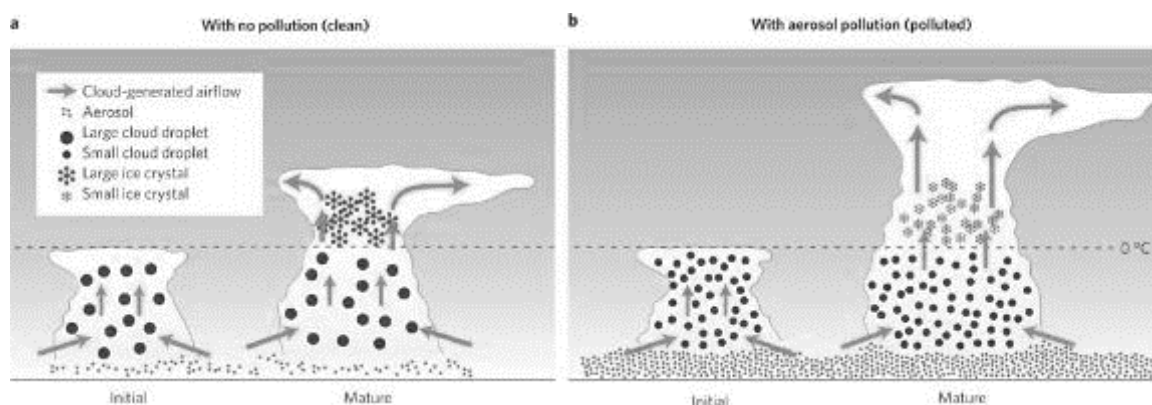


Figure 1: formation of cloud (a) in clean environment, (b) In polluted environment [3].

Mainly black carbon is released into the air by the incomplete combustion of fossil fuels (such as diesel) and wood. The soot, is an extremely small component of air pollution at land surface levels, which creates through black carbon. This phenomenon has a significant heating effect on the atmosphere at altitudes above 2 km (6,562 ft), and also the vapor from air planes, flying high in the sky, were identified as another significant cause of heat reflection [4]. However the other by-products, which cause global dimming, may be an ironic savior. Unfortunately, a deeper look at this, shows that this is not the case. It dims the radiation that falls on the surface of the ocean. That will be the great issue. As an example, vast areas in northern Africa are affected due to the lack of rain fall. This is mainly because the strength of the radiation of sun light is insufficient; therefore, it has interfered with the hydrological cycle by reducing evaporation form Atlantic Ocean.

According to the scientific investigations, it is reported that the impact of global dimming might not be in the millions, but in billions. Rainfall to half the world’s population is brought by Our Asian monsoons. If the impacts of global dimming is persistent alone, it has a detrimental impact on the Asian monsoons so that some 3 billion people could be affected. In addition, it can be devastating because global dimming also lead to various human and environmental problems, such as smog, respiratory problems, and acid rain. This may have already lessened the severity of droughts and lack of rain in the Sahel as well [5]. In 2001, scientists highlighted that this as an interesting finding. In that year, in the United States all commercial flights were grounded for the next three days during the aftermath terrorist attacks (September 11, 2001). This allowed climate scientists to look at the effect on the climate when there were no contrails and no heat reflection. What scientists found was that the temperature rose by some 1 °C in that period of 3 days [6]. In my point of view, what I always feel is Global Dimming is hiding the true power of Global Warming. Modern climate change models predict that over the next century temperature can be increased by 5 °C, which is already considered as a global threat. However, global dimming has led to an underestimation of the power of global warming. Global dimming can be dealt by cleaning up emissions. If global dimming problems are only

Observed tendencies in surface solar radiation

	1950s-1980s	1980s-2000	after 2000
USA	-6 →	5 →	8 →
Europe	-3 →	2 →	3 →
China/Mongolia	-7 →	3 →	-4 →
Japan	-5 →	8 →	0 →
India	-3 →	-8 →	-10 →

Figure 2: Changes in surface solar radiation observed in regions with good station

Coverage during three periods (left column). The 1950s-1980s show predominant declines (dimming) (middle column). The 1980s-2000s indicate partial recoveries (brightening) at many locations, except India and (right column) recent development after 2000 show mix tendencies. Numbers donates typical literature estimates for the specified region and period $W m^{-2}$ per decade. Based on various sources as referred in Wild (2009).

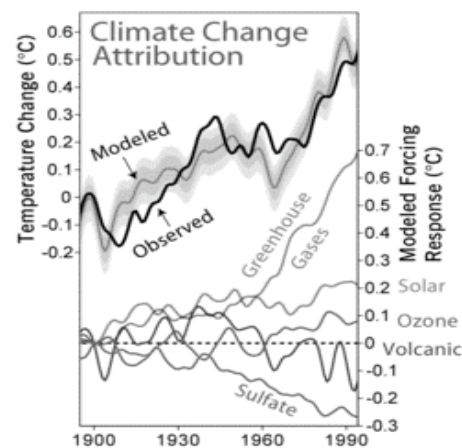


Figure 3: The trend of changing the temperature with years [7]

addressed as what was happened to Europe in 2003, then the effects of global warming will increase even more.

In coming century, it can be the melting of ice in Greenland, which would lead sea levels rising. This in turn would impact many of our major world cities and also it can increase the risk catch fires in rain forests. This would release even more carbon dioxide into the atmosphere, causing increasing the level of global warming, over the next 100 years these and other effects could combine to lead huge temperature rise. Therefore, there is a huge possibility to increase this temperature levels not only by 5 °C but also by 10 °C. The vegetation will die off even more quickly as soil erosion will increase and food production will fall down. Severe climate changes, a Sahara type of climate can be happened in places such as England, while other parts of the world may even become worse. As a result of huge temperature change in the earth there is a possibility to release one of the biggest stores of greenhouse gases such as, methane hydrate, which are presently located at the bottom of the earth's oceans and known to be destabilized with warming. This gas is eight times stronger than carbon dioxide in its greenhouse effect. This will not be a kind of imagination but it is a warning because earth will definitely face to that if the roots of both global dimming and global warming have to be dealt together and as soon as possible. In doing so, we may have to change our way of life. Through this has been a message for over 20 years, as part of the climate change concerns, a little has actually been done. **“We are running out of time.”**

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