SCITECH Nepal

January 2001 Vol. 5 No. 2

Chief Editor:

Deepak Bhattarai

Editors:

A.S.R. Rao
Rukmanath Paudel
Yogesh R. Mishra

Published by:

Nepal Engineering College
Changunarayan,
Bhaktapur,
Nepal.
G.P.O. Box 10210
Phone: 611744
Fax: 977-1-611681
Email: nec@healthnet.org.np

Circulation:

Bishnu Lal Shakya

Price Rs. 50/-

Layout & Printed at:

Time Graphics Printers
Battisputali,
Kathmandu, Nepal.
Tel: 495388

From the Editor

Among several anachronisms debilitating our education system, the most pernicious is the 'affiliating' system, wherein several colleges are affiliated to a single university. The world over, higher education is provided only at university campuses. The affiliating system is a malaise peculiar to our subcontinent alone. It has caused a lot of damage to higher education, specially in the technical sphere. In the affiliating system, a vast majority of teachers have virtually no say in the preparation of curriculum, admission procedures, instruction, evaluation, compilation of results and even research policy. Only a few privileged academics get to be involved in these vital academic activities. No wonder then that colleges are rendered into mere tutorial institutions while the teachers themselves have no sense of participation, with even legitimate academic activities such as setting question papers and evaluation of students taught by them, being denied to them. In this context, the concept of providing academic autonomy to deserving institutions merits serious consideration. This will restore to the academic community its due rights at least in academic matters, if not in administration or policy making. Teachers will have an opportunity to revise curriculum/syllabi at frequent intervals and adopt modern methods of evaluation. In certain engineering fields (such as software engineering) where the shelf-life of knowledge is very short, such a freedom is very vital. However, some academics themselves have genuine apprehensions that autonomy might degenerate into license or that work load will increase. These can be sorted out. But there is no doubt that academic autonomy or a deemed university status will bring modernity into engineering education.

CONTENTS

A GUIDELINE TO DESIGN ENERGY EFFICIENT BUILDING ENVELOPE

S. Sahu*

ABSTRACT

In the context of increasing energy crisis, attention is directed to energy saving strategies in the design of buildings. Invariably, the comfort aspect in the building is neglected in a frenzy to solve problems encountered by designers at all levels. Climate is the main factor which governs the architectural design for creating comfort conditions inside the buildings, whether conditioned or unconditioned.

In tropical regions, solar radiation contributes the maximum to thermal discomfort. The incidence of solar radiation on the surface of the building is directly related to the design of building envelope. Hence, the building envelope needs to be optimized in terms of shape, size, fenestration and orientation, etc. for minimal heat gain and heat loss. This optimal building envelope would prove to be the least energy consuming and the most economical as well.

A study is presented here which provides guidelines to architects and engineers at the initial design stage when the building form is being determined. The study can be applied universally to all categories and types of buildings and the norms and standards affecting the building bye-laws could also be revised in the light of findings of the study to effect overall economy.

INTRODUCTION

There is a vast amount of climatic data available for hot and dry regions. However, lack of studies on integrated building envelopes has left a communication gap between the architects and the building scientists. The experimental work carried out so far on the problems of heat transfer is confined to small dimensioned single storeyed buildings and the inferences drawn from there have been applied universally to all the building envelopes irrespective of their magnitude, which have their own limitations. Although investigations on medium and large size buildings including multistorey buildings have been reported by some authors like W.P. Jones (1974), guidelines are not provided for the designers and the practicing architects for exercising right option in quantitative terms to be followed at the initial design stage.

A new dimension has been evolved by the author in the form of Surface area to Floor area ratio (S_A/F_A) which had not been taken into consideration before. Mention has been made by Olgyay brothers in their book "Sun Control & Shading Devices" but in the form of surface area to volume ratio which has its own limitations while applying to the design of buildings. However, this S_A/F_A index is based upon the concept that minimum surface of a building exposed to direct solar radiation contributes to the maximum thermal comfort indoors.

* Professor, Nepal Engineering College

Therefore, a study was undertaken to investigate into the behaviour of a wide cross section of building envelopes (smm<l to large sized configurations) in single and multistorey situations to find in quantitative terms, the effect of solar heat gain by varying the orientation and fenestration area on a critical day of summer at 29° latitude. The effect of rest of the factors like use of shading device and insulation are additional measures for reducing further heat impact on a building envelope.

FINDINGS

The comprehensive graph which is presented in Fig. 1 is a summary of the findings, which provides a guideline to practicing architects to exercise options of building sizes with full awareness of the quantities of heat gain involved.

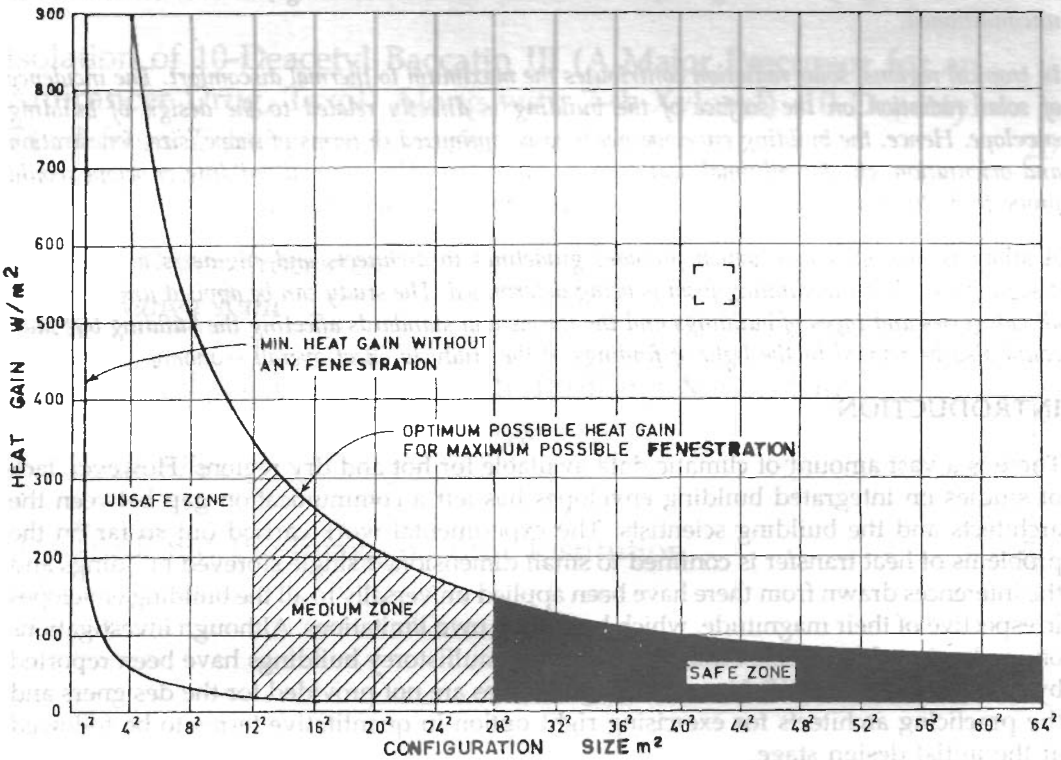


Fig. 1. Guideline to exercise thermally efficient options in the design process

The graph indicates the solar heat gain to a range of square configurations from 4 m × 4 m to 64 m × 64 m placed in the most critical orientation, northeast-southwest. The lower line indicates the heat gain to the total building form in single storey situation, without any fenestration in the walls. The upper line shows the optimum heat gain possible, to this range of configurations with maximum possible fenestration in the walls of the corresponding configuration sizes. These heat gains do not take into account any form of shading devices on the fenestration.

The graph is divided into three zones - Unsafe zone, Medium zone and Safe zone. The unsafe zone includes configuration sizes upto 12 m × 12 m where the heat gain is found to be maximum. The medium zone stretches from 12 m × 12 m to 28 m × 28 m in which the heat gain is of medium intensity. And the third zone above 28 m × 28 m where the heat gain tends to become almost constant.

DISCUSSION

1. The small dimensioned buildings have large exposed wall areas in proportion to the enclosed floor area. Therefore, the solar heat gain is correspondingly large. In these configuration sizes, the wall area being large, the amount of fenestration that could be incorporated is also large (may be of the order of 200 to 300 per cent of the floor area). Therefore, the solar heat gain increases manifold, as the heat gain is directly proportional to the fenestration area.

   To reduce the heat gain in small dimensioned buildings, the windows must be protected by shading devices or insulation material must be used on walls and the roof. In practice, however, it is found that the shading devices are not used on the fenestration of small dimensioned buildings, and as a consequence, the situation is further aggravated in summer months. It is also found architecturally as well as economy-wise that the shading devices on small dimensioned buildings do not meet with the aesthetic and financial requirements.

   There is another implication of using shading devices on small dimensioned buildings. As stated earlier, the wall surface area may be 3 times more than the enclosed floor area. Therefore, the mass of the enclosing structure is likely to be proportionately large. This mass acts as a storage of heat during the daytime and the heat is dissipated to the interior and exterior of the building during nights. Larger the mass, more the dissipation of heat for a longer time. Thus, by providing shading devices on small dimensioned buildings, the mass is increased and the situation is further aggravated.

   It is, therefore, suggested that small dimensioned buildings upto the size of 12 m × 12 m should be avoided as far as possible, or the building units may be combined to form a large dimensioned block like a row of buildings containing small size units with common walls. The second alternative lies in making the small dimensioned building blocks into a multistorey. Even if these blocks are made two storeyed, the reduction in the solar heat gain is found to be of the order of 15.77 w/m^2 and in 5 storeyed buildings by 25.23 w/m^2 (irrespective of orientation, amount of fenestration and percentage of shading) to provide comfortable condition, which is not possible in buildings of this zone otherwise. Because this reduction is substantial when the graph shows the range of solar heat gain between 82.69 w/m^2 and 48.69 w/m^2 for the building sizes of this zone.

2. In medium sized buildings of the second zone ranging from 12 m × 12 m to 28 m × 28 m, the solar heat gain ranges from 48.69 w/m^2 to 38.89 w/m^2. The buildings of these dimensions are most frequently used in practice. In these building sizes, the wall surface area to floor area ratio is small, but still 70 per cent to 20 per cent fenestration area can possibly be incorporated. Therefore, the architects have to take

proper care in providing window areas. The percentage of fenestration area provided in this range must always be checked carefully by the architect for controlling the heat gain. If the shading devices are used over the fenestration in this range of buildings and the architects do not wish to get involved with the computations, it is safe for them to use these building sizes in multistorey conditions, where automatic reduction in the solar heat gain is obtained. Once again, the buildings in the zone could be combined together to form larger dimensioned building blocks.

3. In the third category which has been designated as the safe zone, buildings larger than 28 m × 28 m are included. The solar heat gain in this range varies from 38.89 w/m^2 to 34.72 w/m^2. This range is extremely narrow; therefore architects can use these building dimensions without getting involved with time consuming calculations. The buildings in this range are safest to handle in terms of solar heat gain by virtue of their sizes.

   In this range of buildings, the wall surface area compared to floor area enclosed decreases considerably and is much less than 1. Therefore, the amount of fenestration that can be incorporated is automatically less than 15% as recommended by the research agencies providing in-built control on the freedom of the architects, who are tempted to design glass boxes. In these buildings, the use of shading devices on the fenestration would provide additional reduction in the solar heat gain.

   In multistorey situation these buildings would provide maximum reduction in heat gain and therefore, for buildings which are proposed to be air-conditioned, these sizes are recommended. The town planning regulations could make it obligatory for the intending builders to use only building sizes above 28 m × 28 m if they desire to achieve optimum thermal performance.

CONCLUSIONS

It is normally understood that orientation plays an important role in determining the solar heat gain to the building envelopes.

The foregoing recommendations have been made by subjecting the buildings to the most critical orientation; therefore, they would be within safer range for the other orientations.

The above sets of buildings are subjected to solar heat gain computations in all the eight cardinal orientations. It is found from the results obtained that the effect of orientation goes on decreasing with the increase in dimensions of the buildings. In the third zone buildings, the orientation hardly makes any difference in the solar heat gain. Generally, therefore, one can say that building configurations above 28 m × 28 m in multistorey situation are safest to be used by the architects.

These recommendations are also valid for the rectangular configurations having equivalent areas of the square configurations mentioned above, only the numerical values would differ marginally, which can be interpolated.

Thus, size and shape of building play the most important role in thermal performance. The graph is simple to use for practicing architects who are conscious about the effect of solar radiation to buildings and who want to provide comfortable conditions inside the buildings either by air conditioning or by passive systems.

REFERENCES

Carrier Air-conditioning Co., (1965), *Handbook of Air-conditioning System Design*, McGraw Hill New York.

Jones, W.P., (1974), *Designing Air-conditioned Building to Minimise Energy Use*, Conference on Integrated Environment in Building Design, Nottingham University.

Muncey, R.W., *Thermal Performance of Buildings (As related to Australian Conditions)*, Symposium on Efficiency of Buildings, CBRI, Roorkee, India.

Rao, K.R. and Chandra, P., (1972), *Thermal Performance Rating and Classification in Walls in Hot Dry Climates*, Building Digest No. 101, CBRI, Roorkee, India.

Sahu, S. and Sahu, R.K., *Assessment of the Form and Constituents of Rural Houses with Reference to Thermal Comfort*, Journal of Institution of Engineers, India, Vol 59, Part H 12.

"The closest we ever come to perfection is when we write our C.V.'s or resumes."

***

"If your life is free of failures you're not taking enough risks."

***

"You're not fully dressed until you wear a smile."

***

ARCHITECT'S APPROACH TO MUSEUM PLANNING

*S.V. Sahasrabudhe**

INTRODUCTION

The museum is a place which harbours within its walls or space, ancient fossil, crude stone tools, works of art and many more curious objects. It gathers and exhibits widely distributed materials under one roof. It also carries out identification of objects as a first step towards understanding each of them in detail. It displays such collection under conditions conducive for education and enjoyment. It arouses curiosity and wonder for a visitor to think deeply about artifacts under display. Museum is the only place where three-dimensional and real artifacts are put on display to understand and experience the pleasure out of it while passing through halls and galleries.

HISTORY

The origin of the museum is from personal collection resulting out of interest and liking. It was housed in individual homes in the beginning. As the collection increased in volume and value, a need to put than all under one roof was felt. It further became a public institution of importance for imparting visual pleasure and mental appetite. It is one of the latest contributions to human society after the world war as war has destroyed lot of treasures of rare articles, heritage and buildings. Thus the need for a museum building arose and so new avenues opened for architects to plan and design buildings for such functions.

APPROACH

In the early days, a museum, in general, was arranged in a large prestigious building, having some background to act as nodal point, within the net work of the town. Therefore it is a fact that museums, in the beginning, were not designed but arranged so as to adopt the space within the building for display. There are examples of museums throughout the world, functioning on the principles of adoptive approach. Only after the Second World War the need to house and display the remains of the precious and prestigious heritage of human society, was felt. So massive renovation of war-torn buildings was undertaken everywhere and some of them were converted into today's famous museums. This has started a new movement of museum design in most of the nations. During this operation of renovation, new movement of design elements were introduced as per functional requirements of the museum. The modern museum building design is suitably altered to display the articles as per functional design approach, as against the adoptive approach of the past. From that time onwards, architects were involved in planning and designing of museums rationally.

* Professor, Department of Architecture, Nepal Engineering College

CONCEPT OF MUSEUM DESIGN

The design of a museum firstly depends upon the main theme of museum and secondly the methods of display arrangement. The main theme gives area required, linkages and facilities of the museum, on one hand, but display spells out construction and structural system, on the other hand, to give mass and shape to the building.

There are two most common methods of display in the museum design. They are "stabilized" system and "transition" system. The planning approach is governed by considering both main theme and display system together to evolve architectural concept of design. The stabilized display system is that where no change in arrangement or display in necessary or possible any time in future. In transition system of display, change in display arrangement is necessary and or possible any time in future. The modern design of museum accepts both systems of display.

The concept of museum design depends on types of museums. In case of Art & Archaeology museums, large space and site is required to build upon. The nature of exhibits varies in size, shape and weight in this type of museum. Such museums exhibit a range of objects from small old coins or painting on rice to full scale building components. Hence such museums are designed both indoor and outdoor. They shall have large halls or rooms with a height of 4.5 m. It is to be spread around large open courtyards at intervals.

The exhibits of artwork are displayed in showcases. The size and shape of the showcases depend the articles to be displayed. Long low height glass showcases, single banked for small articles, tall with viewing facility from all sides for large articles and island showcases for objects of three-dimensional view are required. Precious objects are placed in built-in showcases. They provide better and easy security of the articles. Drawings, paintings, engravings and textiles are better placed in suitable showcases along the walls. Narrow and long galleries or corridor serves well than large halls for drawings and paintings. Natural light is necessary for general illumination but artificial lighting is necessary for artwork. For artwork, at times special lighting assists better seeing and minute observation and understanding of the object. Lighting and treatment of background of showcases achieve the visual comforts necessary for a close observation of object.

Archaeology museums are generally designed as partly out-door and partly in-door. The proportion of out-door and in-door area depends upon size, shape and weight of the article under display. Platforms, pedestals, screens and back-ground walls are useful emphasizing elements to be included in the design. Balanced integration of man-made and natural material, in this category of museum, enhances the planning, use and function of the building.

The historical and archival museums may require small showcases placed in big halls with adjacent store space with cabinets and shelves. Artificial lighting is recommended in the showcases so the visitors could see and study the articles easily. Protective devices against fire and theft are necessary. The artifacts in this type of museum are generally dull to look at and so the visitors are likely to pass hurriedly therefore better presentation techniques are very much needed. To arouse curiosity and interest, special efforts are necessary in these types of museums.

Ethnographic and Folk museum may be preferred out-door than in-door. In out door museum full scale examples are put on display. Out-door museum will require more area and the complete site is to be developed properly. In such museums one can see actual persons working and using the space. Visitors may also participate in the process and experience the thrill and mystery of folk life. In case of in-door museums of this type, very large halls as-well-as large dioramas showcases are required to put scaled models to depict the ethnographic evolution in stages clearly.

The technological and educational museums require variety of collection with many sub-divisions. Due to this design of such museums becomes complex, complicated and challenging. In this type of museum series of medium size rooms having transition display system are best suited. In addition to display rooms, special service rooms like laboratories preparation rooms and upkeep rooms are needed.

CONCEPT CONVERSION

In order to convert the concepts into design the display system of articles is very important. It is necessary to identify the nature of display in the museum. In stabilized display system, the display arrangement is more or less permanent and no change is expected in years to come. This is the building dominated museum and its value and character is not likely to change. In this, form follows the function is achieved, whereas in transition system, architect has to foresee the emergence of sub-theme in future from the main theme. This emergence is likely to influence the design. Architect has to accommodate such transitions in the building design with least changes. Therefore the concept conversion in design of museum is dependent on display system.

LIGHTING IN MUSEUM

Natural lighting which is freely available and is best to perceive colours and details, are very important in museum design. The designer has to exploit fully the use of natural light in every hall of museum. The natural light is made available through openings in the wall or roof and it should be well-integrated in structural system of the design. The architect has to evolve design and work-out details by which uniform and diffused light is made available in the entire display hall.

The most common method of lighting is through normal windows in wall. They may be like ribbon windows at lower level or at upper level of the building all around, the bay windows between two adjacent columns, the french windows starting from floor to roof, clare storey lighting and various innovative methods of roof or sky lighting. The draw back of normal window or bay window or french window is formation of different light intensity contours in the halls. Diffusers and or reflectors are required to spread light uniformly and shading devices to keep off the direct solar radiation. The clare storey or sky-lighting allows uniform, steadier and unobstructed light in the halls. It also provides and spares large wall space for display. This type of lighting system generate structural problems and rainwater disposal. The high blank walls, due to roof lighting system, create oppressive claustrophobic effect on visitors if extensively used. It restricts vertical development and thus all the requirements are compulsorily planned on the ground. This method of lighting complicates the design both for construction and structure. It is also difficult for execution and for periodic maintenance. Therefore natural lighting in museum, should be planned through lighting ducts or courtyards of various sizes and shapes. The courtyard planning offers additional space for visitor's services like resting spaces or small refreshments. This will soften the oppressive claustrophobic effect.

Apart from natural lighting, special lighting is necessary in museum design. This additional requirement is met with artificial lights. It is to be planned as per the requirements of the object under display, by providing spotlights at places where it is essential.

Architect has to plan properly the lighting in the museums. The use of lux grid chart for prediction of natural light is recommended at the drawing board stage. Special patented fittings and fixtures like awnings, ceiling diffusers, spot lights and high lights are necessary for effective display in the museum.

ELEMENTS OF DESIGN

Next to lighting, architect has to consider the various elements of planning of museums based on mainly the visitor's requirements. The visitor's requirements are based on location elements, site elements, outside and inside building elements.

There is always a dilemma in location and selection of museum site with reference to the town. The location of museum may be in the central business district of the town or on the out-skirts of the town but area provided be large enough to accommodate all present requirements as well as future demands. The elements supporting the location of museum in the center of town are closeness, easy accessibility and a place to pass time. The museums located in the heart of town are generally housed in a building than in open. It is because of the higher land cost and area limitations. More area and cheaper land is easily available on the outskirts of town where planning of museum is relatively easy and better. Outskirt locations are easy to acquire, cause less fatigue to visitors, are free from noise and traffic and atmosphere is less laden with dust and poisonous gas. The outskirt site should be always readily accessible from all parts of town mainly by public transport system. It should be within reach of various institutions and locations. The outskirt site has less risk of fires, relative protection from dust, noise, vibrations, exhaust gases from vehicles and factories. The sulfur content in the air is less in outskirt locations than center of town, which is harmful to most of the art works. For effective natural filter for dust and to stabilize the humidity of atmosphere providing tree belt around museum building is possible on outskirt site. The tree belt will dilute or naturalize the chemical discharges approaching the site.

The outside facilities are to be planned for visitors which includes public bus stops, imposing entry and exit and parking space for cars, taxies, buses and trucks. The relationship between entrance to museum building and exit is necessary without confusion for visitors. The entrance is to be designed as a distinct feature and should lead to vestibule. It shall have essential facilities like sale of tickets, information service, sale of catalogues and other information. The entrance to museum should be through a big hall by which interest would be aroused in the minds of visitors. It should give all information about the theme of the museum and display arrangement, hall sequence, resting places and cafes etc.

The halls and rooms for the exhibition shall be planned in telescopic manner connecting all areas of display by narrow galleries and wide passages. This arrangement is good for directional movement of visitor and equally better for security of artifacts. Placement of doors, mostly of the same width and heights be planned and placed to unfold entire hall in vision as one enters through it. It is recommended that doorways should be without shutters except where closing is required. Architect has to give due regard to every collection and or material under display to be included in the expected movement of the visitors. The design and visitor's movement within the museum should give evidence that they will feel and find friendly environment and a welcome atmosphere.

While planning the museum the main theme is laid out in spaces in the form of halls, corridors and galleries creating sequence. The monotony and pipe line like arrangement in sequence is undesirable. In order to break monotony, mainly in large museums, visitor's facilities and supporting facilities are to be planned intermittently. Normally more than three-fourth hour viewing time is considered to be monotonous and so the supporting services are needed. This three-fourth hour time is not rigid but varies from person to person, display of artifacts to artifacts and from museum to museum. The supporting facilities are of two types, one for visitors and second for administration. The break in the viewing sequence could be planned for providing snacks; tea or coffee shop children's play lot and supporting attractions. Supporting attractions could be planned in the court yards where tired and or puzzled visitors could get more information about various artifacts under display by a trained staff, labeling them as "Talking Time Terrace" or "Touch Table". They are meant to clear doubts about what visitor has seen, but went unnoticed as well as what one is likely to see next.

"Talking-Time" or "Talking Terrace" is the place where any important topic under display is elucidated audio narration by trained staff, at per-determined time schedule. Here in general or curious visitors could get chance to clear doubts about the subject on display. A child or youth is generally a curious visitor in the museum but all displays are cautioned by notice 'Do not touch'. To fulfil the curiosity of young visitor "Touch Table" facilities are to be planned. The 'touch table' is the facility where some selected articles, in rotations are kept to touch and get the feel and observe them very closely, under supervision of museum staff. The programme may be published in advance for the benefit of young viewers. This touch table facility is bound to arouse interest, satisfy inquisitiveness and remove suppressed desire of most of the young visitors. Almost all museums plan their exhibition space on "No Turn Back" principle but secondary exits leading to some kind of facility are desirable and unavoidable. Planning display in sequence is necessary but traversing the entire length of museum may not be binding and mandatory.

SUPPORTING FACILITIES

The museum staffs who are taking care and making articles presentable to the viewers are to be provided with supporting facilities. The conservation laboratory facility is essential in every museum. Separate space of adequate size, as per the theme of the museum is necessary where flow of newly acquired objects is constantly coming in. The space required for such laboratory will depend upon size, shape volume and weight of the articles. This information will dictate the design requirement. In planning a laboratory, minimum two rooms are required. The size and number of rooms will depend upon rate of inflow of article in museum.

Temporary storage is the next essential requirement of most of the museums. Here articles are documented, studied in detail and assessment for preservation and treatment is required. Accordingly the article is either sent to conservation laboratory, or preparation laboratory or to permanent store or display as the case may be. In the conservation laboratory, at least two laboratory tables and one island table is required. The acid proof tabletop is must as in various treatments of conservation, use of acids is made. The storage space should be well ventilated and control of humidity is necessary to keep articles in good form.

Security and safety of individual articles and the whole building is necessary against fire and theft. Precautions are to be taken in planning and design of the building and management of museum by installing modern gadgets. Close circuit television camera and alarm system for constant monitoring of each hall is a very good asset for security of museum. The fire safety is achieved by properly providing fire-fighting equipment as per requirements.

SPECIFICATIONS OF ELEMENTS

The planning is incomplete without giving proper thought to structural systems and specification of materials to be used in and constructional details to be adopted in the building. The structural system derived from concept conversion, will govern the form of the building and further on the architectural details of every element.

The wall area should be as maximum as possible so that more display surface is made available for the articles. The transparent surface in roof should be about one-third of the roof area. It should have easy access to periodic cleaning. The flooring in display halls of museum should be durable, maintenance free and darker in colour. The floor in the museum is expected to undergo a lot of wear and tear as it is extensively used daily. The concrete floors are darker in colour and economic, durable, maintenance free and also dust free. They can easily be polished and does not absorb dampness. The only drawback of such floor is noise and unattractive appearance. Therefore other types of floors like stone, marble, wood, cork, tiles of different materials and rubber are recommended where damping of noise is essential. The selection of proper flooring material will make movement of visitor comfortable and also enhancement of artifacts is possible.

CONCLUSIONS

Museum planning is a process of inter-action between purpose, requirements and conditions of display of artifacts according to the main theme of museum. All aspects and requirements of the museum are to be decided by the architect in consultation with museum manager and curator. The designer, as a creator of building, has to understand the display system and its sequence requirement properly for design decisions. One has to decide the best suitable viewing angle and distances, background and lighting along with safety and security of the article, at the drawing board stage. The volume, value and verity of articles under display govern the planning requirements of museum, as per its category. The type of visitors, category of museum administrative staff and building design adopted to give uniform diffused natural light in each and every hall and room also governs the planning of museum. Long end travel of no return for the visitors are short-circuited at reasonable intervals for the relief of the puzzled viewer. Selection of proper specifications of building material and constructional details are the real testing areas of design.

Finally design approach to museum planning is not a single person's creation but needs co-operation and team effort of all, mainly the creator and the curator.

"The telephone is one of the most effective time savers and one of the biggest time wasters."

***

"If you are right you can afford to keep your temper; if you are wrong, you cannot afford to lose it !"

***

"Today is worth two tomorrows."

***

"Winners make things happen - losers let things happen."

***

INTERPRETATION AND APPLICATION OF REMOTELY-SENSED DATA

Deepak Dhungana

ABSTRACT

This paper reviews several aspects of the geological interpretation of Spaceborne Aperture Radar (SAR) images. Topics reviewed include the characteristics and coverage of currently available SAR image data, the effects of incidence angle and frequency, and the phenomenon of subsurface radar imaging. A review of applications of currently available remotely sensed data is also presented.

VIEWPOINT

Imaging radar has a superficial similarity to aerial photography. The illumination is oblique, coming as it does from the side of the scene. The appropriate viewing direction is from the side of the scene. The appropriate viewing direction is from above the image, at right angles to the transmitted microwave energy. Perspective from this viewpoint is created by the progressive time delay proportional to the distance in the scene from the radar. Indeed, first order geometric effects such as elevation displacement become equivalent between radar and aerial photography in this frame of reference, as reflections from taller objects are shifted away from the viewpoint nadir, thus towards the radar in side-looking geometry (Fig. 1).

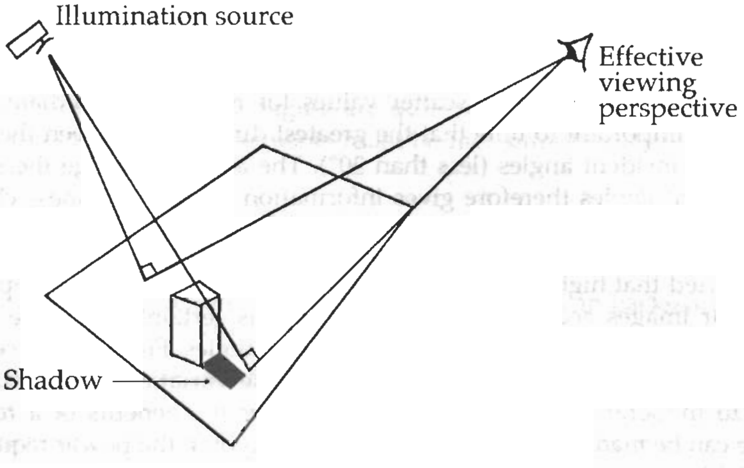


Fig. 1. Interpretation aid for radar imagery

The primary variables which control radar image tone (brightness) are in order of decreasing effect : slope, roughness and dielectric constant (including the effect of soil moisture). Each of these variables gives information valuable to the geologist.

EFFECTS OF INCIDENT ANGLE

Orbital radar images are acquired at a great distance from the terrain (as opposed to airborne radars) the angle subtended by even a 100 km swath is quite small. In viewing a temporarily invariant target, without changing the wavelengths, the angle of incidence becomes the primary variable. To illustrate the general behaviour of different surfaces as a function of incident angle, the schematic backscatter curve (Fig. 2), may be considered.

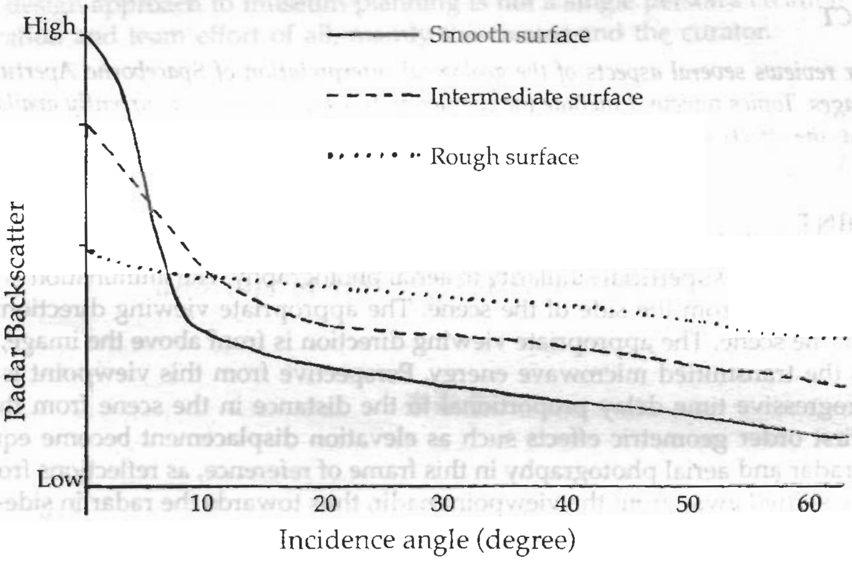


Fig. 2. Schematic radar backscatter curves showing relative echo strength as a function of incidence angle

Note the difference in relative backscatter values for rough, intermediate and smooth surfaces. It is also important to note that the greatest difference between the surfaces are at relatively small incident angles (less than 30°). The ability to image the same surface at different incident angles therefore gives information on the roughness characteristics of the surface.

It has been asserted that higher incident angles are more desirable for mapping on radar images. In radar images acquired from aircraft, this is certainly true due to the rapid variation in illumination of geometry at small incident angles. From the spaceborne radar, however, the distortion induced by the incident angle variation is minimal. In fact in areas of low to moderate relief a strong argument for the benefits of a relatively low incident angle can be made. Also from a practical standpoint, the power requirements are almost intractable at near grazing incident angles from space.

EFFECTS OF FREQUENCY

The primary factors which control radar backscatter (and hence the image tone) are surface slope, surface roughness and dielectric constant. Of these factors, the surface roughness response is strongly frequency dependent and others less so. A useful measure of surface roughness is the Rayleigh roughness criterion. This measure has been used to explain radar backscatter of fan gravel and lava flows by Schaber *et al.* (1990). The parameters are related as :

$$\text{Smooth} : h < \frac{\lambda}{8 \sin \gamma}$$

$$\text{Rough} : h > \frac{\lambda}{4.4 \sin \gamma}\text{, where}$$

h = height of surface irregularities or surface roughness
λ = radar wavelength
γ = grazing angle between terrain and the incident radar wave.

Surfaces which are smooth will reflect the radar energy away from the sensor in specular manner and hence be recorded as a black image tone. Surfaces which are rough are strong diffuse scatters, back-scattering strongly and thus are very bright on radar images. Intermediate values are displayed as various grey levels in radar image. A multi-spectral radar image consequently has the capability of describing the roughness of various surfaces. Longer wavelength radars are potentially more useful for the discrimination of various surfaces because a wider range of surfaces will respond with intermediate grey levels. Experience shows that this is generally true, but other factors also influence image quality and its utility. First, any surface which is a specular reflector is recorded as a black image tone. Lakes, dry lake beds, smooth ice and others alike can therefore be confused. Context is frequently, but not always an aid. Secondly, shorter wavelength air borne systems usually have better resolution than the available spaceborne images. Thus a short wavelength radar image commonly is easier to interpret because the higher resolution and fewer smooth specular surface yields more contextural clues.

SUB-SURFACE RADAR IMAGING

The requirements of sub-surface imaging are quite strict. Review of the radar literature indicates that the following requirements must be met simultaneously in order for sub-surface imaging to occur :

1. The surface to be penetrated must be smooth to the incident radar beam, otherwise it would backscatter and be detected by the radar.
2. The sub-surface to be detected must be rough so that it can backscatter the incident beam.
3. The material to be penetrated must not be too thick, otherwise the signal will be attenuated during passage in and out of the materials. Two to five meters appears to be the maximum depth through which an image can be formed.
4. The medium to be penetrated cannot have scatters embedded within it. It must be homogenous fine grained material.
5. Most importantly, the moisture content must be below 1%. Moisture content above this causes more energy to be specularly reflected away at the upper surface/air boundry and increases the signal attenuation within the penetrated medium by raising the loss tangent of the material.

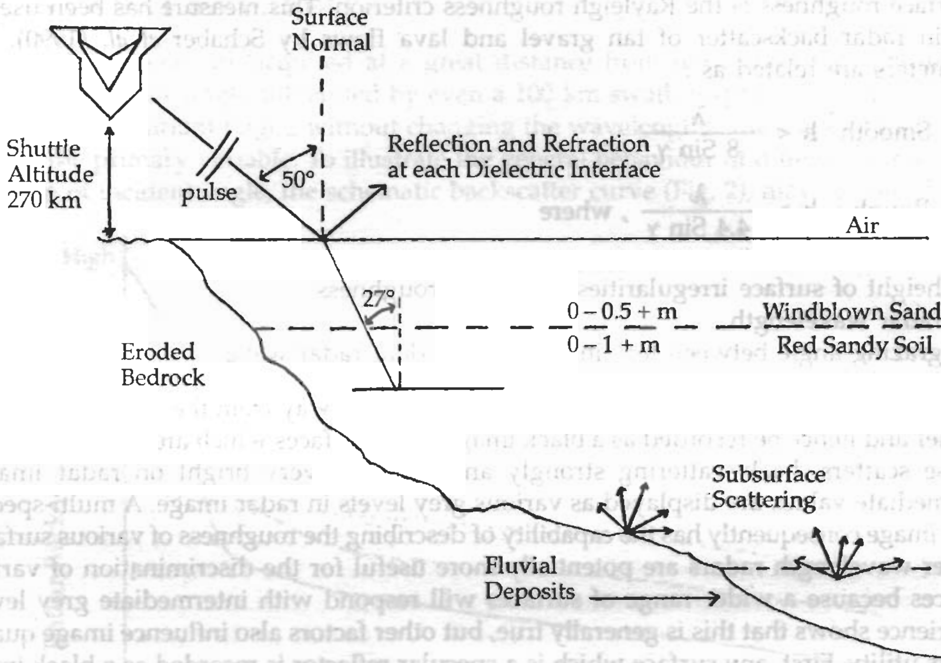


Fig. 3. Diagram showing refraction and reflection of the radar wave at air/surface boundary with sub surface scattering, producing an image of the sub surface

Assuming all of the above conditions are met, there are two interesting effects which occur that increase the echo-strength from the sub-surface. The first effect is that the wavelength of the incident radar beam is actually shortened. As a consequence, a sub-surface need not be as rough as the same surface exposed to produce the same echo-strength. The second effect is that the incoming radar beam is refracted, thus, the incidence angle is reduced at the sub-surface as compared to the surface. Under favourable conditions, a sub-surface feature may in fact have a stronger echo than if it were exposed at the surface. Because radar is sensitive to roughness and highlights subtle topographic features, and because radar is not deterred by the sand cover, excellent maps can be drawn directly from the radar images once the radar signatures of the various types are known. Figure 3 illustrates the principle.

APPLICATIONS OF REMOTELY SENSED DATA

Remote sensing by satellites and digital processing of data have become indispensable tools in applied geology. A broad range of applications are possible, e.g. geological mapping, exploration for geothermal resources and mineral deposits, geomorphological mapping and vegetation mapping.

Management of the environment is one of the most urgent challenges of our time. With rising consumption of renewable resources, such as cereals and wood, it becomes increasingly necessary to survey existing cultivated areas as well as to identify new regions that might be suitable for cultivation. Both tasks can be furthered by remote sensing techniques, with the following specific objectives.

i. Improve the scientific understanding of the environment.
ii. Develop and promote practices to better handle available resources.
iii. Promote and develop applications of remote sensing techniques.

Here are some of the established procedures that have been implemented, utilizing remotely sensed data.

1. In food storage alerts : to monitor potential draughts in developing countries.
2. In global mapped vegetation index : to monitor crop estimates.
3. In warnings : to detect and monitor volcanoes, river effluents, hurricanes etc.
4. In search and rescue.

The benefits to mankind of remote sensing from space have been demonstrated over the past 40 years. Through international cooperation these benefits will continue to be available to all nations.

REFERENCES

Barkan, C.B., Hunneycott, B. *et al.*, (1995), *An Introduction to the Interim Digital SAR Processor and the Characteristics of the Associated SEASAT SAR Imagery*. JPL Pub., April 10.

Colwell, R.N., (1993), *Manual of Remote Sensing*, (Fifth edition), American Society of Photographmetry : Falls Church, VA.

Guido, E. and Righini, M., (1990), *An S-band Receiving System for Weather Satellites*, August 1980.

Sabins, F.F. Jr, (1998), *Remote Sensing Principles and Interpretation*, W.H. Freeman and Co., San Francisco.

Schaber *et al.*, G.G., (1996), *Variations in Surface Roughness within Death Valley, California : Geological Evaluation of 25cm Wavelength Radar Images*, Geological Society of America.

"Wise people learn by other's mistakes; fools by their own mistakes."

ISOLATION OF 10-DEACETYL BACCATIN III (A MAJOR PRECURSOR FOR AN ANTICANCER DRUG, TAXOL) ALONG WITH 7-(β-XYLOSYL) -10-DEACETYL TAXOL FROM *T. BACCATA* SUB. *WALLICHIANA*

*Pramod Prasad Poudel**
*Mangala Devi Manandhar***
*Ronald D. McKelvey****

ABSTRACT

Phytochemical screening and brine-shrimp bioassay of Taxus baccata sub. wallichiana were carried out. 10-deacetyl baccatin III, 7- (β-xylosyl) -10-deacetyl taxol along with β-sitosterol and sciadopitysin were isolated and identified from Taxus baccata sub. wallichiana.

INTRODUCTION

Disease, death and decay have co-existed with life, therefore discovery of new diseases and exploration of medicinal value of indigenous plants are found to be contemporaneous with human civilization. Medicinal plants have historical importance also. The uses of many medicinal plants so far have been mentioned in Rigveda which is said to be written between 4500 B.C. and 1600 B.C. Nowadays also many people of our country especially those who live in rural areas, use some specific plant-parts to treat specific diseases. Vaidhyaraj and Kaviraj are very popular in our country in identifying the utilization of specific plant-parts for specific diseases. They can cure some diseases by direct utilization of plant-parts as such but they do not know the chemical constituent actually involved in doing so. In contrast, a nowadays chemist can isolate the chemical constituent of plant-parts in pure form. He can identify the isolated compounds. He can detect the biological activity of isolated compounds. But, initially he doesn't know whether the specific plant-part is responsible in curing some diseases or not. So, the utilization of primary knowledge of Vaidhyaraj and Kaviraj by a good chemist may lead to good findings from medicinal plants. Only the selective parts such as leaf, bark, fruit, flower etc. of medicinal plants contain active compound and their amount in medicinal plants is very low. So, medicinal plants alone can not fulfil the increasing demand of medicine for various diseases. That is why people have to depend upon synthetic drug.

Our country, Nepal, is also rich in medicinal plants. Among medicinal plants of Nepal, *Taxus baccata* is of most importance because it contains an anticancer drug, *taxol*.

Taxol is considered to be one of the most important novel natural anticancer drug. This substance could kill any kind of human cancer cells grown on mice. Although total

* Formerly Research Student, Tribhuvan University
** Professor and Head of Department, Central Department of Chemistry, Tribhuvan University
*** Professor, University of Wisconsin-La-Crosse, U.S.A.

synthesis of taxol from commercially available material is not done yet, it can be synthesized from some intermediate compounds (precursor) present in the *Taxus species*. 10-deacetyl baccatin III which is found in the leaves of *T. baccata* is the most important precursor of taxol. *Taxus baccata* also contains several taxol like compounds having anticancer activity. Taxol prevents the mitotic cell division. It is used in treating several cancer like head and neck cancer, lung cancer, skin cancer and most notably breast and ovarian cancer.

One gram of taxol costs about US $ 600 in USA and about 2 grams of it is needed to cure the breast-cancer.

Though *T. baccata* is one of the most important medicinal plant, it is in the category of highly threatened species, and may disappear from forest of Nepal due to the excessive legal and illegal collection of plant parts and smuggling to neighbouring countries.

Thus, prevention of Taxus from illegal exportation and development of advanced technique to isolate taxol and its precursor 10-deacetyl baccatin III will help to decrease the number of cancer-patients of the country.

Taxus baccata belongs to the class coniferophyta of order coniferales (Sporne, 1965). It is commonly called as Himalayan Yew and locally called Barme Salla, Thunar, Chire Salla, Singhe and Talispata. In Nepal, the branches of plant are highly sought each year to decorate the holy cart during the Indra Jatra Festival.

In the rural area of the country, the leaves of the yew are used in asthma, bronchitis and for indigestion. The plant, as a whole is poisonous and is used as fish-poison as well.

T. baccata is reported from east Afghanistan, Khasi-Jaintia, Naga-hills, Indo-China, Western China, Vietnam, Malaysia and Nepal.

In Nepal, the plant is reported in temperate Himalayan region from a height of 1800 m to 4000 m. The place of representative collection is given in Table 1.

EXPERIMENTAL INVESTIGATION

Phytochemical Screening

Phytochemical (Phyta - plant, chemical = chemical substance) screening is the process of detecting the different types of chemical substances present in a plant. The procedure followed for the phytochemical screening was obtained from Prof. I. Ciulei. The procedure is given as such in "A Dissertation Submitted To Central Department of Chemistry by Pramod Prasad Poudel (2000)". The results obtained from phytochemical screening to *T. baccata* sub. *wallichiana* (the plant under study) are tabulated in Table 2.

Biological Screening

It is the process of detecting the biological activity of plant-extract or pure compound. There are various methods to detect biological activity. The present research work includes brine-shrimp bioassay.

Table 1. Location of *T. baccata*

Local place	District	Altitude (m)
Inguldwar	Bajhang	2710
Surma Sarover - Thogun danda	Bajhang	3400
Khaptad	Doti	3750
Salingade-Choya Katneodar	Doti	2650
Suligad	Dolpa	2900
Manichur	Kathmandu	2150
Bagdwar	Kathmandu	2500
Sheopuri lekh	Kathmandu	2780
Chhatan to kebang	Mustang	2400-2500
Chimang forest	Mustang	3350
near Tukuche	Mustang	2590
Chhatang Larijung	Mustang	2550
Dumpas	Mustang	2450
Thanchok-Chane	Lamjung	2730
Ulleri Nayathanti	Lamjung	2100
Ghodepani	Parbat	2000
Taplejung	Taplejung	2590
Naragaon to Thekpu	Sankhuwasava	2410
Guphepaheri	Sankhuwasava	2700
Chintapu	Panchthar	2980

Table 2. Phytochemical Screening to *T. baccata*

S.N.	Different Group of Substance	Remarks
1.	Volatile oil	–
2.	Alkaloid	–
3.	Fatty acids	+
4.	Coumarins	+
5.	Flavon aglycones	+
6.	Emodins	+
7.	Triterpene	+
8.	Steroids	+
9.	Saponins	+
10.	Tannins	+
11.	Polyoses	–
12.	Lactones	–
13.	Reducing Compounds (oxos)	–
14.	Anthracenosides	–

+ = Present   – = Absent

Brine-shrimp Bioassay

The method for brine shrimp bioassay is based on the procedure as given by Mayer *et al.* The procedure is given as such in "A dissertation Submitted to Central Department of

Chemistry by Pramod Prasad Poudel (2000)". In this method, newly hatched brine shrimp nauplii (a sea animal) are exposed to the plant extract or the isolated compounds and the biological activities are evaluated on the basis of their toxicity towards these nauplii. This method determines the Lc-50 value for the samples under study and those having Lc-50 value less than 1000 are supposed to be pharmacologically active.

The Lc-50 value of chloroform extract of *T. baccata* sub. *wallichiana* (actual sample under chemical analysis) was found 46.23. Thus, the extract was found highly cytotoxic.

Material and Methods

The needles of *Taxus baccata* were collected from Jumla and identified by botanist. The needles were shade dried and powdered. 1000 gms of dried, powdered plant material was extracted with methanol (7x200 ml) at room temperature for 24 hours for each extraction. Methanol extract was distilled under reduced pressure to yield semi solid product. To the semi-solid residue, water (about 75 ml) was added. The resultant aqueous alcoholic extract was fractionated with hexane to get hexane-extract (35 grams) and with chloroform to get chloroform extract (35 grams). 20 grams of chloroform extract was chromatographed through a Silica gel-packed column (60-120 mesh 3.5 x 60 cm). *Taxus baccata* afforded five compounds.

RESULTS AND DISCUSSIONS

Characterization of the isolated compounds was carried out, as described below.

Compound PP1 (MM111) : 10-deacetyl baccatin III.

Compound PP1, m.p. 245°C, Rf-value 0.40 (EtOAc: Hexane, 1:4) was a white crystalline solid. The IR-spectrum showed the presence of - OH at 3500 cm^{-1}, alphatic C-H at 2940 cm^{-1}, aromatic C-H at 3040 cm^{-1}, Carbonyl group at 1735 cm^{-1} and C = C at 1610 cm^{-1}. The ^{1}H-NMR spectrum integrated to about 36 hydrogens. There were four methyl singlet at δ 1.08, 1.11, 1.72 and 2.26. These values were accounted for hydrogens of C-17, C-16, C-19 and OAc respectively. Doublet at 2.06 was accounted for 18CH_3. There were five aromatic hydrogens, two ortho hydrogens appeared at 8.12 (d), para hydrogens at 7.66 (t) and two meta hydrogens at 7.66 (t). Doublets at 5.65, 5.27 and 4.04 were accounted for proton at C-2, C-10 and C-3 respectively.

There were four hydroxy proton at 4.60 (d), 4.19 (d), 4.16 (s) and 3.54 (s). The peak at 4.97 (dd), 4.91 (m), 4.36 (dt) and 4.26 (d or 2S) were accounted for the proton on C-5, C-13, C-7 and C-20 respectively. α-hydrogens of C-6 and C-14 were appeared at 2.46 (m). β-hydrogen of C-14 appeared at 2.33 (dd) while that of C-6 appeared at 1.82 (ddd). The NMR data of compound PP1 matched the literature data of 10-deacetyl baccatin III.

Desorption ionization Mass-spectrum (DI-Mall) using Sodium as matrix showed the peak at 567.2 (m^{+}+Na). Thus, the molecular weight of compound must be 544. The other peaks at 498.8, 413.3, 325.0, 200 and 176.0 (base peak) were due to fragmentation of the molecule.

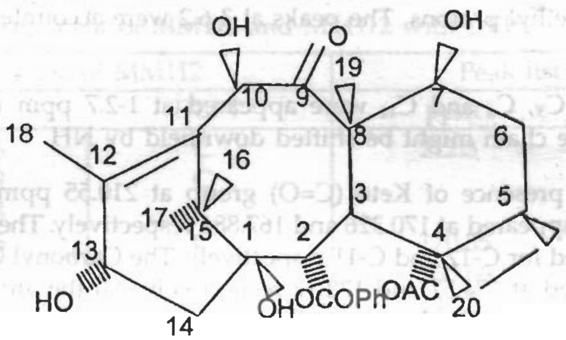
C-13 NMR showed twenty seven signals; out of which two signals were assigned for ortho-and para-carbons of mono-substituted benzene ring. Thus C-13 NMR showed the compound had 29 carbons which was in favour of 10-DAB III. On the basis of DEPT experiment assignment of carbon (whether it was CH_3, CH_2, CH or carbon not attached to hydrogen) has been carried out. The assignment of Carbons and δ value were tabulated in Table 3.

Table 3. Assignment of Carbons and δ value

C-13 NMR (PPM) of PP1 (MM111)	DEPT assignment of PP1 (MM111)	Remarks
212.296	C	C=O (Keto)
170.84	C	C=O, Acetate
166.65	C	C=O, Benzoate
143.50	C	C-12
135.69	C	Quaternary Carbon
134.02	CH	Para Carbon
131.60	C	C-11
130.80	CH	Meta Carbon
129.43	CH	Ortho Carbon
85.14	CH	C-5
81.47	C	C-4
78.62	C	C-1
76.89	CH_2	C-20
76.08	CH	C-2
75.83	CH	C-10
72.62	CH	C-7
67.96	CH	C-13
58.66	C	C-8
48.07	CH	C-3
43.72	C	C-15
40.96	CH_2	C-14
37.75	CH_2	C-6
27.26	CH_3	C-16
22.77	CH_3	OAc
20.65	CH_3	C-17
15.37	CH_3	C-18
10.33	CH_3	C-19

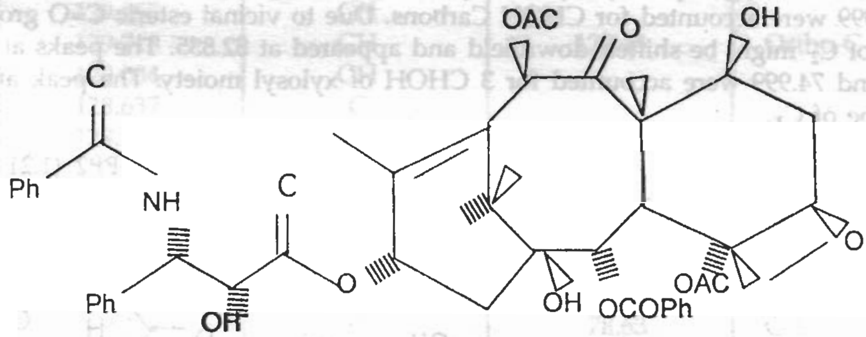
The C-13 NMR with DEPT assignment of compound PP1 matched the literature data of 10-deacetyl baccatin III.

All the above spectral facts concluded that the compound MM_{111} (PP_1) should be 10-deacetyl baccatin III. The structure of the compound is given below.



(10-deacetyl baccatin III)

The compound 10-deacetyl baccatin III is very important because it can be easily converted into taxol (an anticancer drug). The structure of taxol is given below.



(Taxol)

Compound PP2 (MM112) : 7- (β-xylosyl) - 10-deacetyl taxol

Compound PP2, m-p. 250°C, Rf-value 0.52 (MeOH: EfOAc, 1:5.6) was a white crystalline solid. The IR-spectrum showed presence of -OH group at 3450 cm^{-1}, aromatic C-H at 3000 cm^{-1} and carbonyl group at 1650 cm^{-1}. The UV-spectrum at λmax (MeOH) 233.8 nm showed the presence of unsaturated chromophore.

^{1}H-NMR, C-13 NMR and DEPT showed that the peaks of MM112 matched with that of MM111 (10-deacetyl baccatin III) with respect to chemical shift and DEPT multiplicity. Thus, MM112 may contain similar Carbon-skeleton to that of 10-deacetyl baccatin III. The additional peaks can be accounted for the xyloside moiety and the side chain at C_{13}.

^{1}H-NMR integrated to about fifty four hydrogens. Some of the hydrogens may exchange with deuterium from the methanol solvent. The structure required 15 aromatic hydrogens. The Spectrum integrated to about 17 in the aromatic region. The one 'H' at the aromatic range might be accounted for NH. The singlets at 2.38, 1.90, 1.66, 1.16 and 1.12 were accounted for five methyl protons. The peaks at 3-6.2 were accounted for 14 protons (14 CH-O).

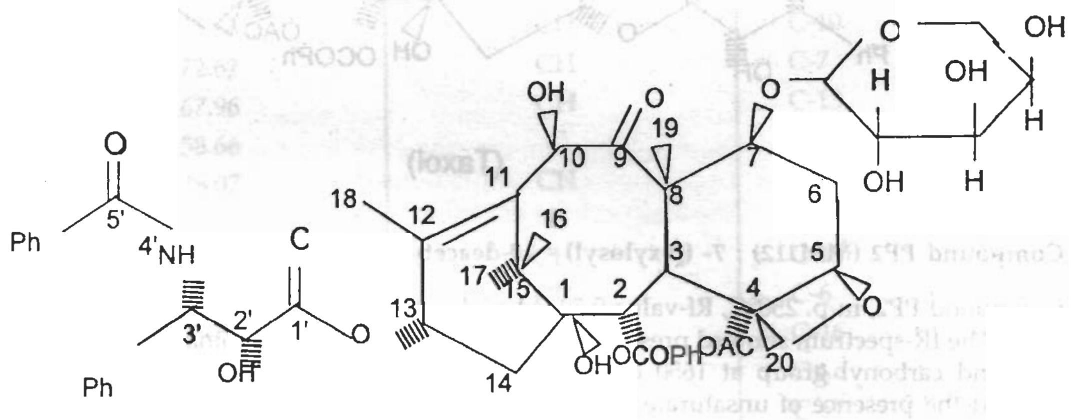
The protons on C_3, $C_{3'}$, C_6 and C_{14} were appeared at 1-2.7 ppm range. The benzylic hydrogen on the side chain might be shifted downfield by NH.

C-13 NMR showed presence of Keto (C=O) group at 210.55 ppm. Acetate C=O and benzoate C=O were appeared at 170.326 and 167.884 respectively. The peak at 140.225 and 131.60 were accounted for C-12 and C-11 respectively. The Carbonyl Carbon (C=O) on $C_{1'}$ and $C_{5'}$ were appeared at 174.57 and 172.17 respectively. All the aromatic Carbons were appeared at 128.446 - 139.554 ppm. Anomeric Carbon of xyloside moiety shifted down field and appeared at 106.654 ppm.

C-NMR assignment of MM111 (10-deacetyl baccatin III) and MM112 with DEPT is tabulated in Table 4.

Table 4 shows the similar peaks of MM111 and MM112. The peak at 67.086 may be accounted for CH_2 group of xylosyl moiety. The four CH groups at 82.835, 78.058, 75.102 and 74.999 were accounted for CHOH Carbons. Due to vicinal esteric C=O group, the CHOH of $C_{2'}$ might be shifted downfield and appeared at 82.835. The peaks at 78.058, 75.102 and 74.999 were accounted for 3 CHOH of xylosyl moiety. The peak at 57.828 should be of $C_{3'}$.

The above spectral facts lead to the conclusion that the compound PP2 (1.21 grams) should be 7-(β-xylosyl) - 10-deacetyl taxol. The structure of the compound is given below.



7-(β-xylosyl)-10-deacetyl taxol

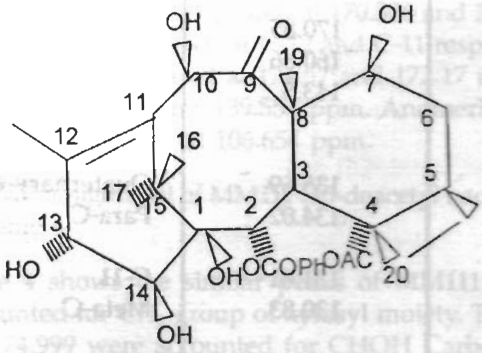
Compound PP4 (MM114)

Compound PP4, m.p. 210°C, Rf-value 0.56 (MeOH: EtOAc, 1:9) was white crystalline solid. UV-spectrum showed λmax (MeOH) at 273.6 nm and 240.2 nm. IR-spectrum showed presence of carbonyl group at 1735 cm^{-1} and - OH group at 3500 cm^{-1}. mass spectrum

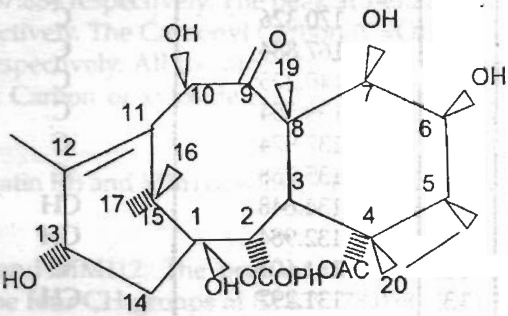
Table 4. C-NMR assignment of MM111 and MM112 with DEPT

S.N.	Peak list of MM112		Peak list of MM111	
	ppm	DEPT	ppm	Remarks
1.	210.553	C	212.3	C=O of C-9
2.	174.579	C		
3.	172.173	C		
4.	170.326	C	170.85	C=O, Acetate
5.	167.884	C	160.66	C=O, Benzoate
6.	140.225	C	143.5	C-12
7.	139.554	C		
8.	137.974	C		
9.	135.768	C	135.69	Quaternary-C
10.	134.648	CH	134.02	Para-C
11.	132.984	CH		
12.	131.604	C	131.61	C-11
13.	131.297	CH	130.83	Meta-C
14.	129.808	CH		
15.	129.718	CH	129.43	Ortho-C
16.	129.084	CH		
17.	128.637	C		
18.	128.579	CH		
19.	128.446	C		
20.	106.654	CH		
21.	85.831	CH	85.14	C-5
22.	82.835	CH		
23.	82.381	C	81.47	C-4
24.	79.319	C	78.63	C-1
25.	78.058	CH		
26.	77.674	CH2	76.89	C-20
27.	76.457	CH	76.09	C-2
28.	76.143	CH	75.84	C-10
29.	75.102	CH		
30.	74.999	CH		
31.	72.744	CH	72.63	C-7
32.	71.031	CH	67.97	C-13
33.	67.086	CH2		
34.	58.072	C	58.66	C-8
35.	57.828	CH		
36.	48.266	CH	48.08	C-3
37.	44.720	C	43.72	C-15
38.	37.084	CH2	40.91	C-14
39.	36.734	CH2	37.76	C-6
40.	27.187	CH3	27.27	C-16
41.	23.335	CH3	22.77	OAc
42.	21.784	CH3	20.66	C-17
43.	14.645	CH3	15.38	C-18
44.	11.487	CH3	10.34	C-19

showed m/e at 560. ^{1}H-NMR and C-13 NMR data were found very close to that of 10-deacetyl baccatin III. DEPT showed that one CH_2 signal of PP1 (10-deacetyl baccatin III) changed to CH in PP4. The total spectral analysis showed that the compound PP4 might be either 6-hydroxy-10-deacetyl baccatin III or 14-hydroxy-10-deacetyl baccatin III. In both the cases, the compound will be new to the natural product dictionary but it has to be confirmed yet.



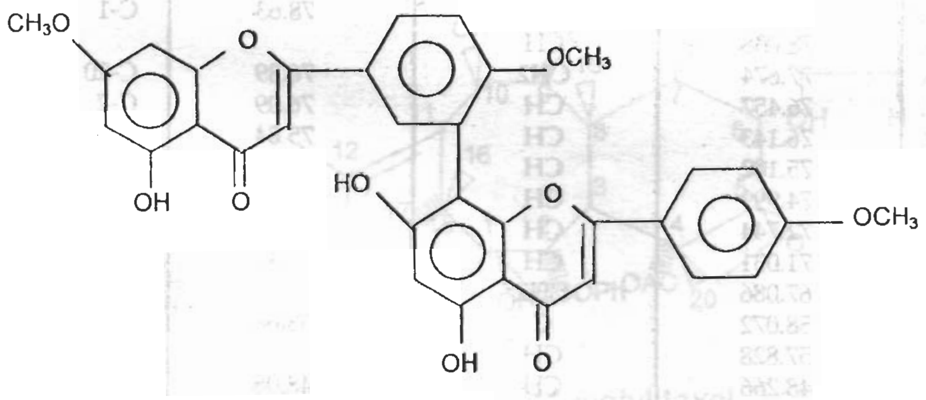
14-hydroxy-10-deacetyl baccatin III



6-hydroxy-10-deacetyl baccatin III

Compound PP7 : Sciadopitysin

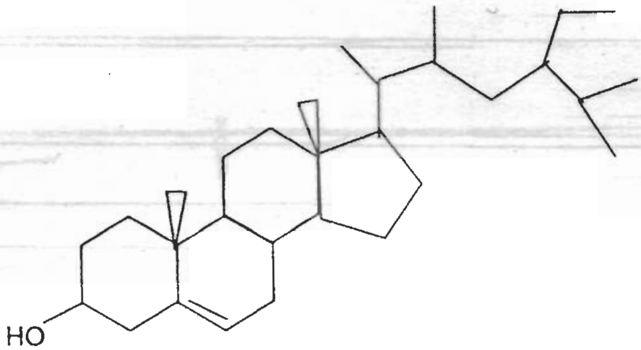
Compound PP7, m-p 282°C, Rf-value 0.48 (Hexane: EtOAc, 3:7) was a yellow crystalline solid. The compound was assigned as sciadopitysin by direct comparison with authentic sample previously isolated from the same species in our laboratory.



Sciadopitysin

Compound PP8 : β-sitosterol

Compound PP8, m-p 138°C, Rf-value 0.42 (EtOAc: Hexane, 1:3) was white crystalline solid. UV-spectrum showed maximum absorption at 242.2 nm. The compound was assigned as β-sitosterol by direct comparison with authentic sample previously isolated from the same species in our laboratory. The identification of the compound PP8 as β-sitosterol was further confirmed by preparation of its acetyl derivative (m-p. 135°C).



β-sitosterol

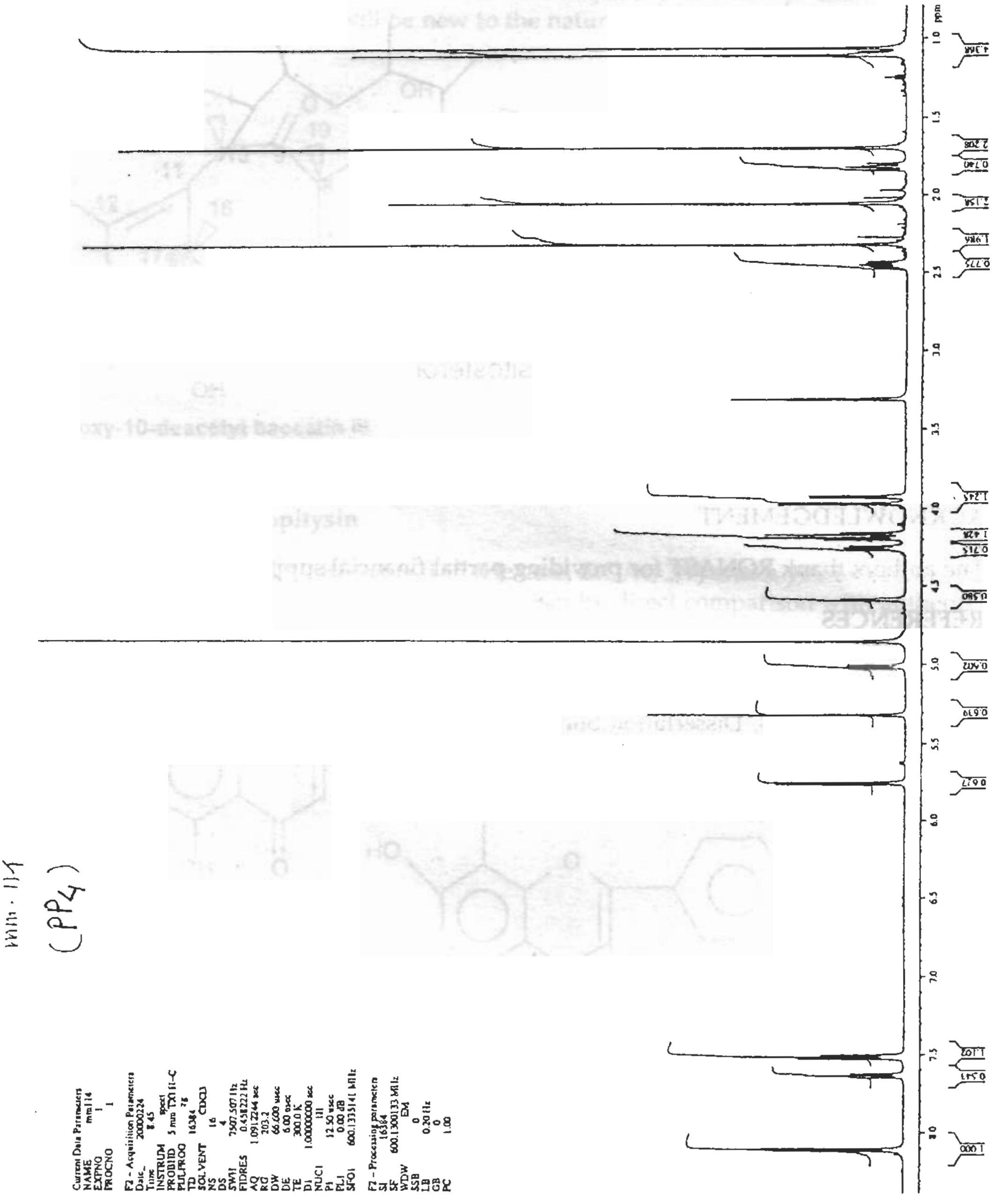
ACKNOWLEDGEMENT

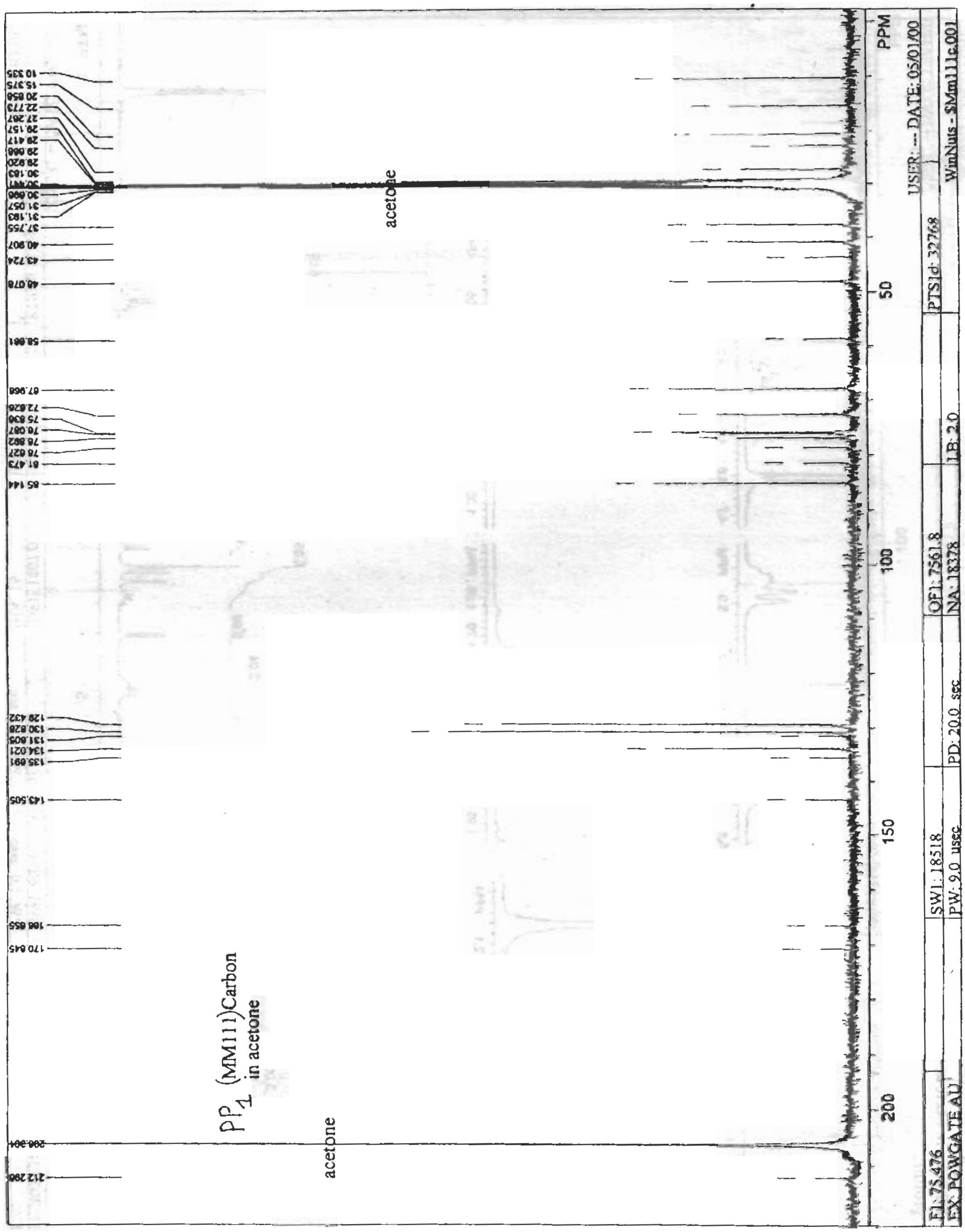
The authors thank RONAST for providing partial financial support for the investigation.

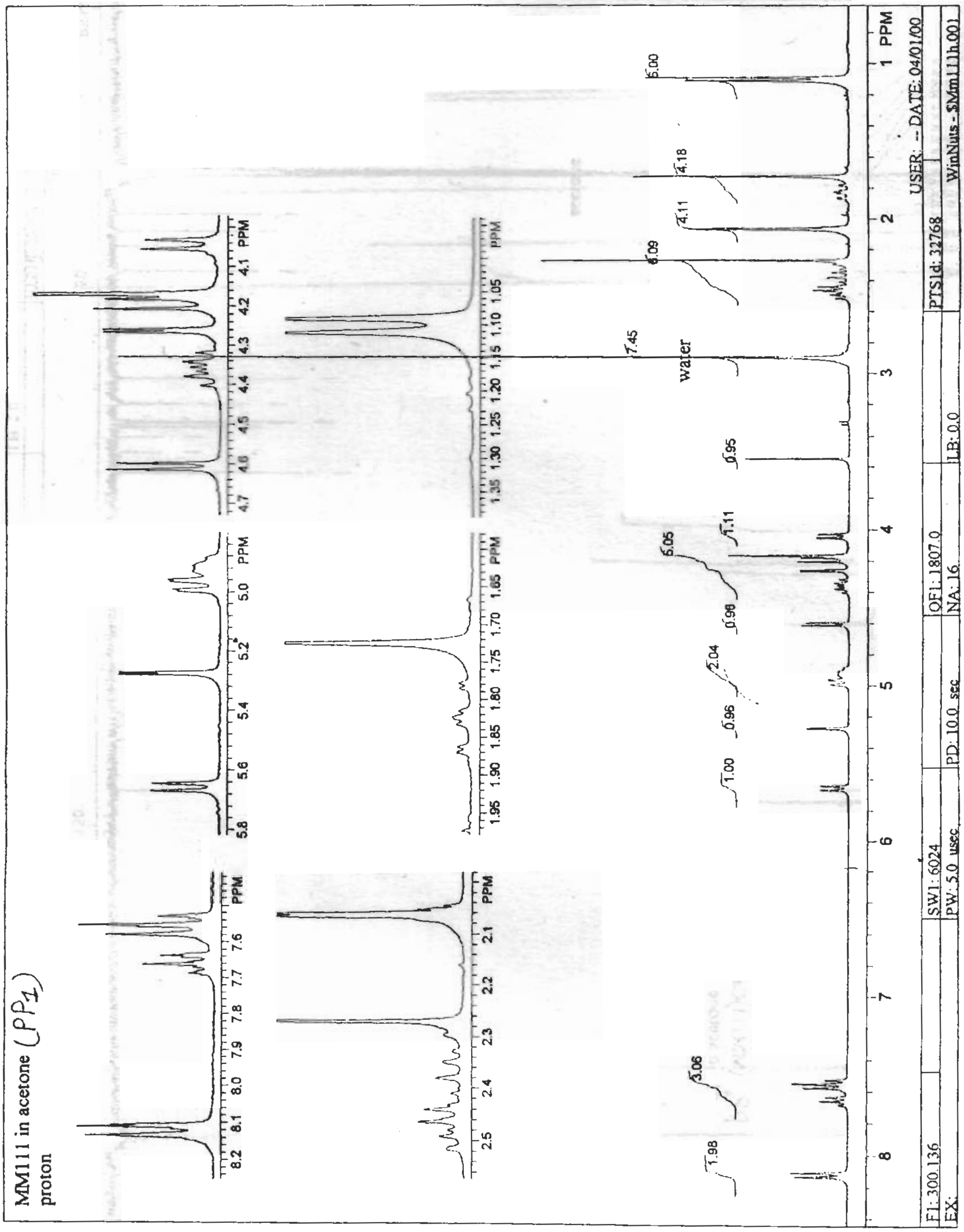
REFERENCES

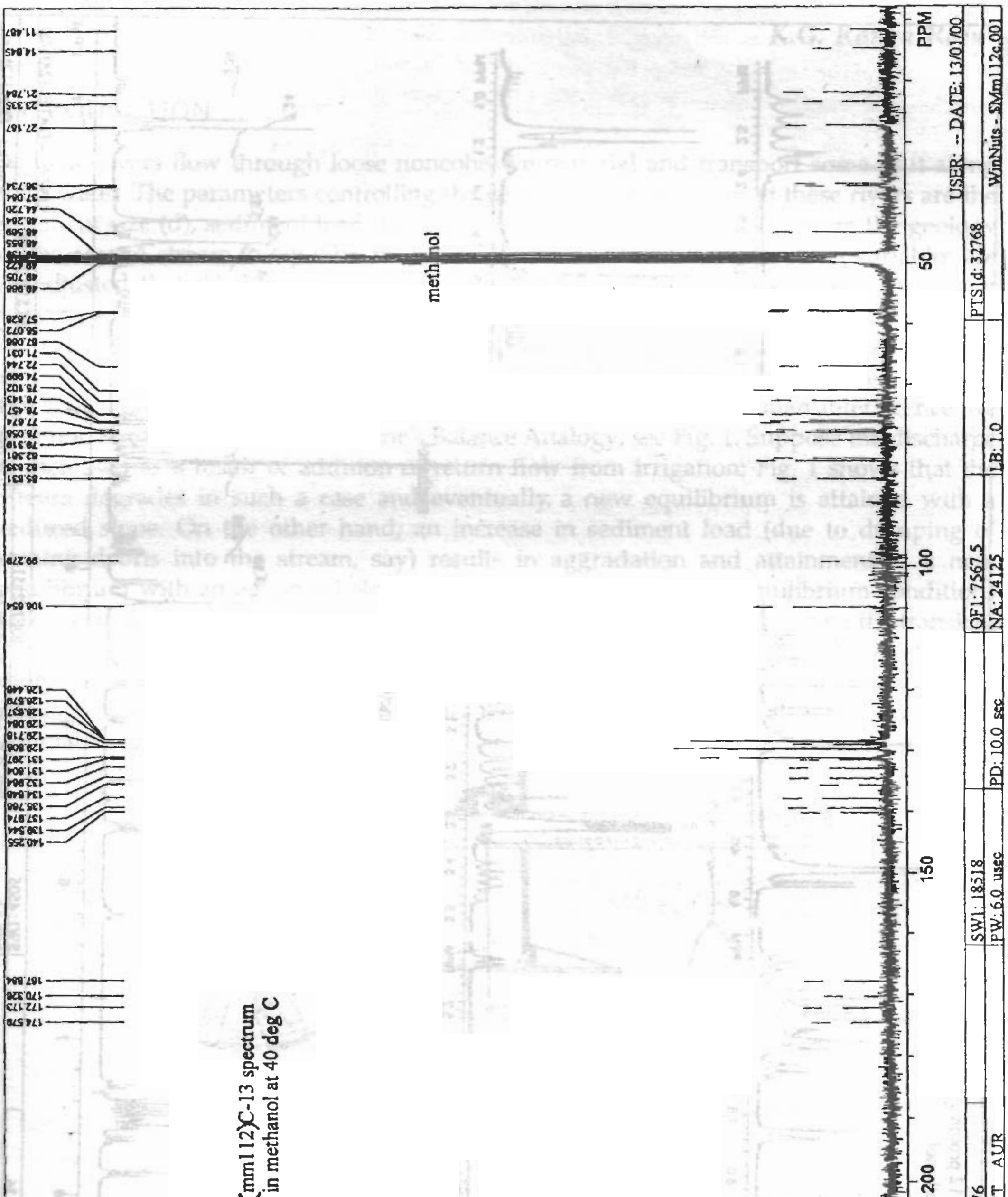
P.P. Poudel, (2000), Dissertation Submitted to Central Department of Chemistry.

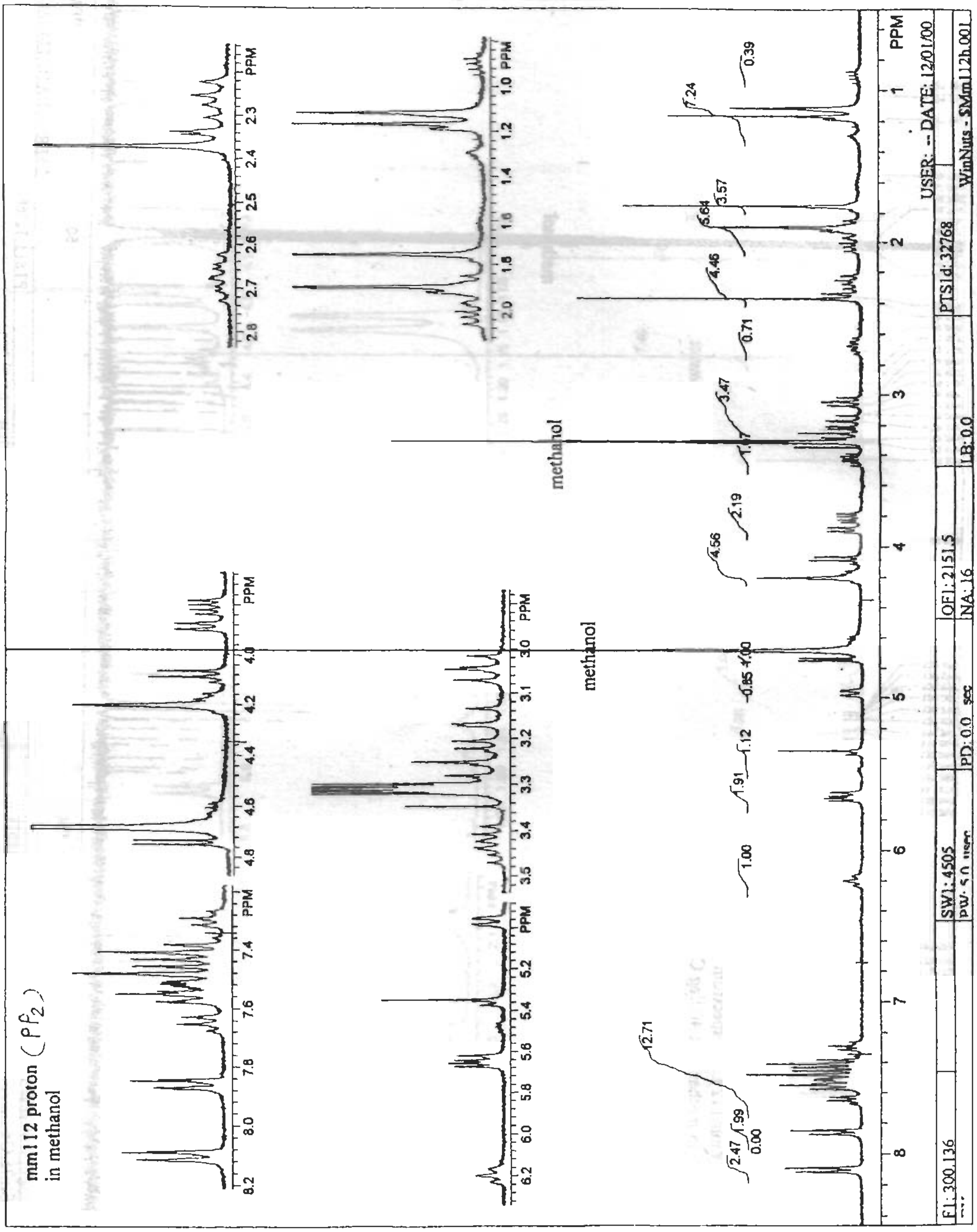
T.B. Shrestha, (1995), Dissertation Submitted to Central Department of Chemistry.




PP1 (MM111)Carbon
in acetone
acetone
acetone
PPM
50
100
150
200
USER: --- DATE: 05/01/00
WinNuts - $Mm111c.001
PTSId: 32768
OF1: 7561.8
NA: 18378
LB: 2.0
SW1: 18518
PW: 9.0 usec
PD: 20.0 sec
F1: 75.476
EX: POWGATE.AU


MM111 in acetone (PP1)
proton
water
PPM
F1: 300.136
EX:
SW1: 6024
PW: 5.0 usec
OF1: 1807.0
PD: 10.0 sec
NA: 16
LB: 0.0
PTS1d: 32768
USER: -- DATE: 04/01/00
WinNuts - $Mm111h.001


PP2(mml12)C-13 spectrum
in methanol at 40 deg C
methanol
PPM
50
100
150
200
USER: -- DATE: 13/01/00
WinNuts - $Mml12c.001
PTSld: 32768
LB: 1.0
OF1: 7567.5
NA: 24125
SW1: 18518
PD: 10.0 sec
PW: 6.0 usec
F1: 75.476
FX: DEPT AUR


mm112 proton (PF2)
in methanol
methanol
methanol
PPM
F1: 300.136
SW1: 4505
OF1: 2151.5
PTS1d: 32768
USER: --DATE: 12/01/00
PD: 0.0 sec
NA: 16
LB: 0.0
WinNuts - SMm112h.001

ALLUVIAL RIVER PROCESSES

*K.G. Ranga Raju**

INTRODUCTION

Alluvial rivers flow through loose noncohesive material and transport some of it along with water. The parameters controlling the geometry and the form of these rivers are the sediment size (d), sediment load (G), discharge (Q) and slope (S) apart from the geology of the area. A stream in equilibrium is one in which all the four controlling variables are so adjusted that the bed level and the cross section of the stream are stable and not varying with time. Any change in the value of one or more of the controlling parameters disturbs this equilibrium leading to aggradation or degradation. The concept of an equilibrium stream and the response of such a stream to changes in the value of any of the controlling variables due to natural causes or as a result of human interference are best understood by reference to Lane's Balance Analogy; see Fig. 1. Suppose the discharge is increased as a result of addition of return flow from irrigation; Fig. 1 shows that the stream degrades in such a case and eventually a new equilibrium is attained with a reduced slope. On the other hand, an increase in sediment load (due to dumping of mining debris into the stream, say) results in aggradation and attainment of a new equilibrium with an enhanced slope. The attainment of the new equilibrium conditions takes several years and quantitative estimates of the bed level changes during the transient phases as well as under the new equilibrium conditions can be made with the help of morphological models available today. A discussion of these models and their capabilities needs an understanding of the mechanics of sediment movement and the hydraulics of alluvial rivers.

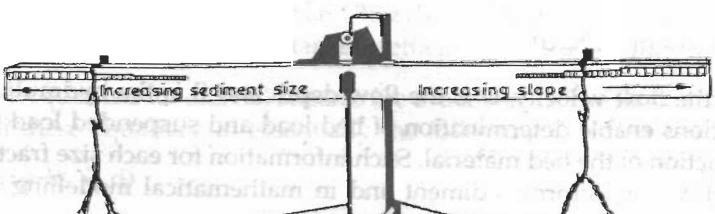


Fig. 1. Lane's Balance Analogy

* Pro-Vice Chancellor & Prof. of Civil Engg., University of Roorkee, Roorkee, India

MODES OF SEDIMENT TRANSPORT

A sediment particle on the bed of a stream resists the shear force exerted by the flowing water on account of its self-weight and intergranular friction. When the fluid dynamic force exceeds the resisting force, the particle starts moving. The shear stress at which the particles just begin to move is called the *critical shear stress.*

One mode of movement of sediment particles is by rolling or sliding along the bed. Such movement of the sediment is usually discontinuous; the particle may roll or slide for some time, remain stationary for a while, and again start rolling or sliding. Sediment transported in this way is known as *contact load*. A second mode of sediment movement is by hopping or bouncing along the bed whereby, for some time, the particle loses contact with the bed. Material transported in this way is known as *saltation load*. Saltation is an important mode of transport in case of noncohesive material of relatively high fall velocities, such as sand in air and, to a lesser extent, gravel in water. The third mode of transport is in a state of suspension. In this case the particles are supported by the turbulent fluctuations. Material supported in this way and transported by the flow is know as *suspended load.*

It is usually difficult to measure saltation load and furthermore, saltation load is very small in the case of flow of water over sandy beds. Hence contract load and saltation load are grouped together and called *bed load*. Thus, *bed load* is the material transported on or near the bed. Bed load movement is restricted to a bed layer about two grain diameters thick and the load carried in the rest of the flow depth is suspended load.

Knowledge of the amount of sediment transported by the flow is required in the solution of all practical problems related to alluvial rivers. A large number of sediment transport relations is available (1) and they take the form

$$G = f\,(U, D \text{ or } R, S, d) \tag{1}$$

in which U is the flow velocity, D is the flow depth and R is the hydraulic radius. These transport relations enable determination of bed load and suspended load transport rates of each size fraction of the bed material. Such information for each size fraction is required in case of highly nonuniform sediment and in mathematical modelling of phenomena like aggradation and degradation.

BED FORMS AND CHANNEL RESISTANCE

Sediment movement is accompanied by the formation of an array of interesting bed features. A gradual increase in discharge above that required to initiate sediment movement results in the occurrence of various bed forms in sequence from (a) to (f) shown in Fig. 2. Ripples, which are unsymmetrical undulations of small size, appear almost immediately after the onset of sediment motion. With increase in discharge, they grow into dunes. Dunes are known to be several hundred meters long and of height of about one-third the depth of flow in large rivers. The dunes tend to get washed out at higher discharges leading to a nearly plane bed. At still higher discharges, when the Froude number exceeds unity, symmetrical bed and water surface waves called antidunes form.

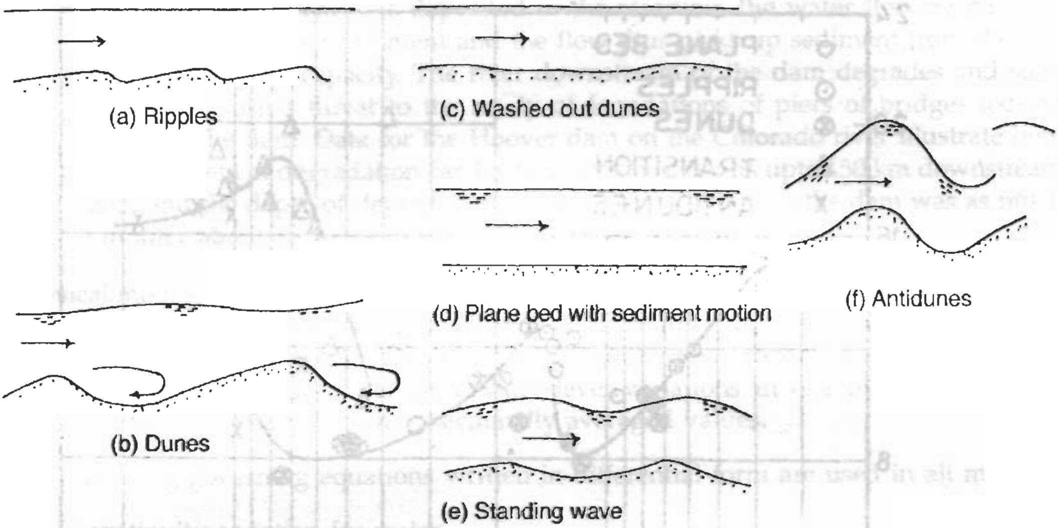


Fig. 2. Different Bed Forms Obtained in Alluvial Streams

When the bed is undulated as above, the resistance due to the presence of the sediment particles is augmented by the resistance of the bed forms and the flow resistance is thus much more than that of the plane boundary under the no-motion condition. Figure 3 shows the variation of the Chezy's coefficient (C) with the shear stress (in dimensionless form) for alluvial-channel data collected in a laboratory flume. Here $U = C\sqrt{RS}$ $\tau_o = \gamma_f RS$, $\Delta\gamma_s = \gamma_s - \gamma_f$, τ_o being the shear stress and γ_s and γ_f the specific weights of the sediment and fluid respectively. Note that the resistance coefficient has changed by a factor of 2.5 with change in discharge and a consequent change in the bed condition. It is for this reason that conventional resistance equations like Chezy's and Manning's equations cannot be used with a constant value of the resistance coefficient in case of alluvial streams.

Several resistance equations for alluvial streams are available (1). The functional relationship employed in all these equations in essentially the following :

$$U = f\,(D \text{ or } R, S, d) \qquad (2)$$

The present state of the subject is such that, with the best of the available relations, the flow velocity in alluvial streams can only be estimated with an accuracy of ± 30%.

MATHEMATICAL MODELS

Rivers respond to changes in any of the four controlling variables (Q, S, d, G) by aggrading or degrading. These phenomena of aggradation and degradation can extend over considerable distances and can also result in significant bed level changes. Consider the case of a high dam built on an alluvial river (Fig. 4). The water surface slope upstream of the dam decreases and the stream responds by aggrading as per Fig. 1. This phenomenon of reservoir sedimentation leads to continuous loss of reservoir capacity. Reservoirs are known to lose about 1% of their capacity on the average due to sedimentation and computation of sedimentation rates is thus necessary to work out the progressive reduction in storage capacity.

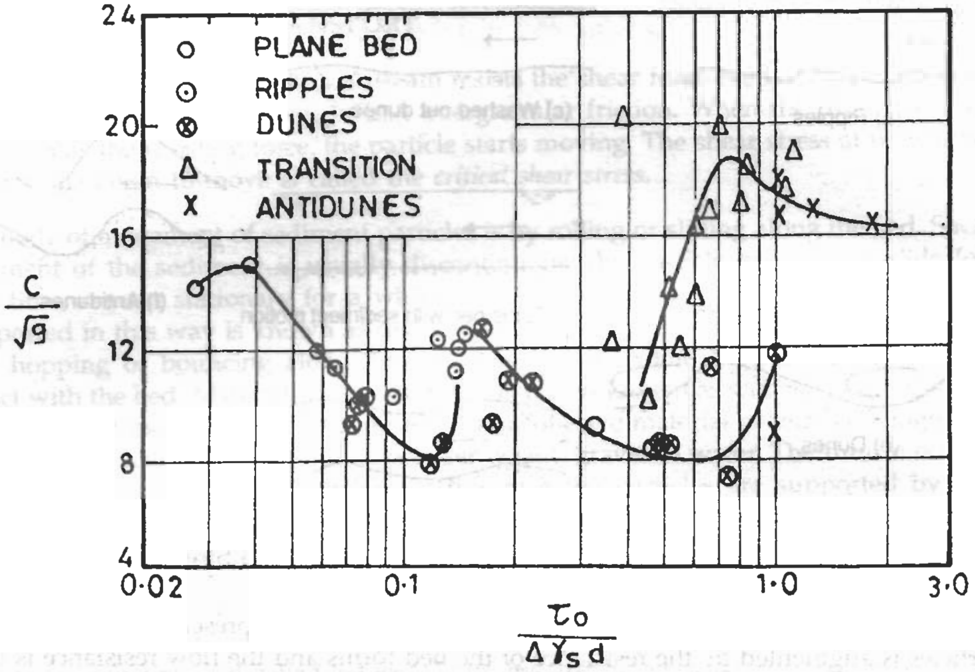


Fig. 3. Variation of Chezy's Coefficient with Change in Shear Stress (d = 0.45 mm)

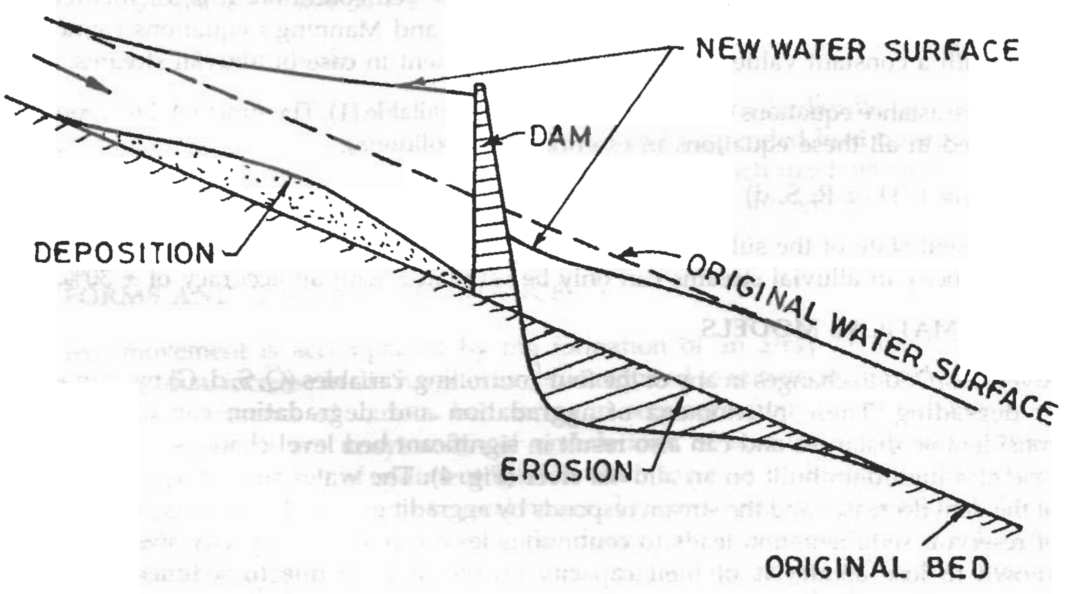


Fig. 4. Aggradation and Degradation near a Dam

Since most of the sediment gets deposited in the reservoir, the water flowing past the dam is relatively free from sediment and the flow thus picks up sediment from the bed and banks to satisfy its capacity. The river downstream of the dam degrades and such degradation can pose a threat to the safety of foundations of piers of bridges located downstream of the dam. Data for the Hoover dam on the Colorado river illustrate how serious the problem of degradation can be. Degradation extends upto 150 km downstream of the dam and the depth of degradation at a place of 19 km from the dam was as much as 4.30 m after about 15 years of operation of the reservoir.

Physical models are not convenient to use for the study of aggradation and degradation, because of the larger lengths over which they occur. Mathematical models are well suited for studying these phenomena. Most of the well established models are one-dimensional and enable computation of bed and water level variations in one direction, viz. the longitudinal direction, using cross-sectionally averaged values.

The following governing equations written in differential form are used in all models :

(i) continuity equation for water

(ii) continuity equation for sediment

(iii) Equation of motion for water

These along with a transport equation and a resistance equation [viz. Eqs. (1) and (2)] are solved numerically for the given set of boundary conditions to obtain bed level changes. That reliable results can be obtained from the use of such models is shown in Figs. 5 and 6. Figure 5 shows a comparison of the observed and computed bed levels in a reservoir (in India) upstream of the dam. The model predictions are also in good agreement with the observations in the case of a dyke failure (in USA) as per Fig. 6. As such, mathematical models are commonly used today in the study of several alluvial river processes.

PLAN FORMS OF RIVERS

Figure 1 has been shown to be an excellent tool for a qualitative analysis of river response to any change in one or more of the controlling variables. This analogy is, however, not helpful in a study of the possible change in the plan form of a river. The commonly occurring plan forms of rivers are *straight, braided* and *meandering*. The braided pattern of the yellow river (in China) and the meandering pattern of the Gomti river (in India) are shown in Figs. 7 and 8 respectively. A river may have different plan forms in different reaches of its course and the plan form in a particular reach could also change as a result of changes in slope or discharge.

The one-dimensional mathematical models discussed before are not useful in the study of plan form changes. Although 2-D and 3-D models are aimed at addressing this problem, they are not as well developed as the one-dimensional models. Consequently, one uses a fair amount of empiricism and relies on practical experience in handling problems related to plan form changes. For example, the design of river training measures at bridges and barrages on meandering alluvial rivers is based on empirical relations developed on the basis of physical model studies and practical experience.

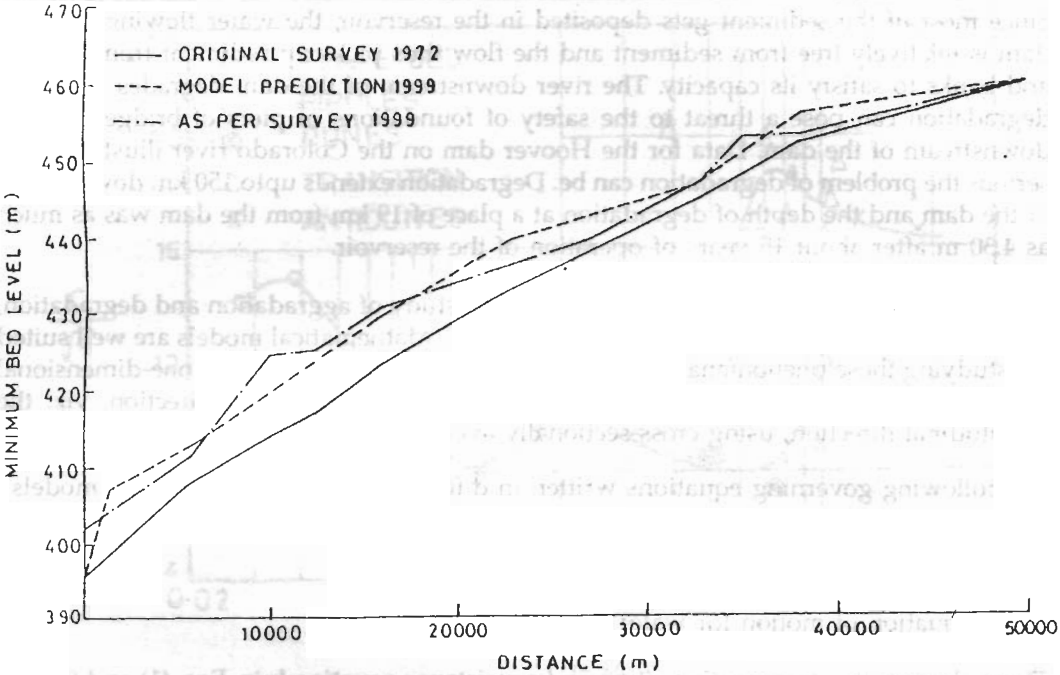


Fig. 5. Mathematical Modelling of Reservoir Sedimentation

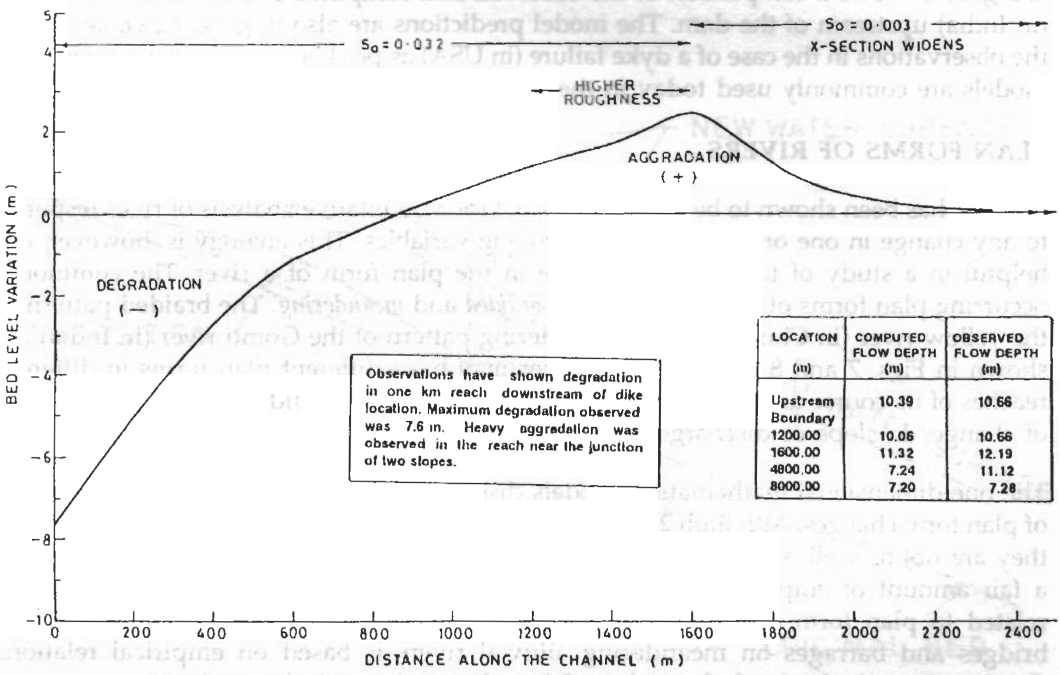


Fig. 6. Mathematical Modelling of Aggradation and Degradation Caused by Dyke Failure

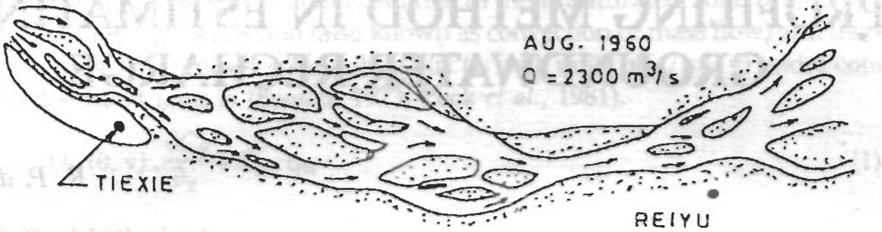


Fig. 7. Typical Braided Reach of the Yellow River (China)

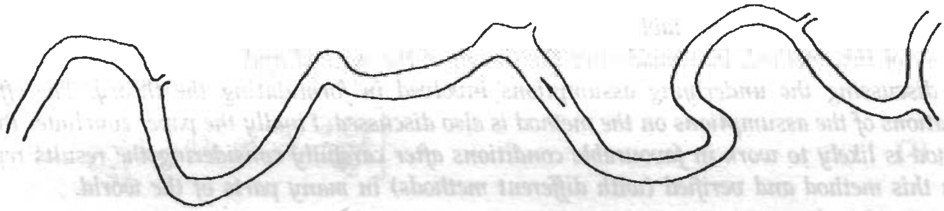


Fig. 8. Typical Meandering River – Gomti at Lucknow (India)

CONCLUDING REMARKS

Alluvial rivers are complex systems in which there is considerable interaction between water and sediment. The equilibrium of these rivers is disturbed when a change occurs in any of the controlling variables as a result of natural causes or human interference. Mathematical models are quite useful in making computations of bed and water level changes over long river reaches in the cases of aggradation and degradation. The more complex cases of changes in plan forms and river training at bridges and barrages are handled using a mixture of theory and empiricism with a fair degree of reliance on practical experience.

REFERENCE

Grade, R.J. and Ranga Raju, K.G., (1985), *Mechanics of Sediment Transportation and Alluvial Stream Problems*, Wiley Eastern Ltd., New Delhi.

A REVIEW OF THE USE OF CHLORIDE PROFILING METHOD IN ESTIMATING GROUNDWATER RECHARGE

*R. P. de Silva**

ABSTRACT

The use of environmental chloride as a tracer in the unsaturated soil zone to estimate rates of recharge to the goundwater table is widely used in many parts of the world. This paper reviews the use of this method, by considering the theory of the method and very importantly analysing and discussing the underlying assumptions involved in formulating the theory. The effect of deviations of the assumptions on the method is also discussed. Finally the paper concludes that the method is likely to work in favourable conditions after carefully considering the results reported with this method and verified (with different methods) in many parts of the world.

INTRODUCTION

Surface water sources are increasingly proving inadequate to meet the demand for water (for domestic, industrial and agricultural uses) in many countries. This is very much so in the developing countries where the population also increases significantly increasing the pressure on already scarce water sources. Therefore, wherever possible, governments have resorted to the development of the groundwater resource to meet the ever increasing demand for water.

Before the groundwater resource is developed, its potential (i.e., the amount of groundwater available) needs to be assessed along with the rate of replenishment of the water table or recharge.

A number of methods are available for the estimation of recharge to an aquifer. They are the soil water balance method, lysimeter method, using tritium as a tracer, measuring groundwater level fluctuation and numerical modelling of the movement of water through the root zone using the Darcy equation (Allison *et al.*, 1994; Hendricks and Walker, 1995). A relatively new and a simple method is the use of environmental chloride (mainly in rainwater) to trace the movement of soil water in the unsaturated (soil) zone and hence make an estimate of the rate of recharge to the groundwater table (known as the chloride profiling method).

This paper, reviews the use of environmental chloride as a tracer to estimate rates of recharges to the goundwater table.

* Department of Agricultural and Plantation Engineering, Open University, Nawala, Nugegoda 10250, Sri Lanka

THEORY OF CHLORIDE PROFILING METHOD

The movement of (chemically inactive) solutes in the unsaturated zone primarily consist of two mechanisms, viz., advection (also known as convection or mass flow) and dispersion. Considering these two processes, the solute flux (Js with units of $g/m^2/y$) under conditions which are described later is (Bresler, 1973; Peck *et al.*, 1981).

$$J_s = -D_h(\theta, v) \cdot \frac{\partial C_z}{\partial_z} + C_z \cdot q_w \tag{1}$$

where $D_h(\theta, v)$ is the hydrodynamic dispersion coefficient (m^2/y) which is a function of volumetric soil moisture content (θ) and average soil moisture velocity (v with units of m/y), C_z is the concentration of solute (mg/l), q_w is the volumetric soil moisture flux (i.e., the rate of recharge at a particular depth or the amount of water moving per unit area in a unit time with units of m^3/y per unit area = m/y) and z is the space co-ordinate (measured positive downwards from the soil surface in m). Rearranging equation 1, the soil moisture flux q_w is obtained by;

$$q_w = \frac{1}{C_z}\left[J_s + D_h(\theta, v) \cdot \frac{\partial C_z}{\partial_z}\right] \tag{2}$$

The assumptions made in deriving the above equations are discussed and analysed in detail later in the paper.

The process of advection, meaning movement of solutes dissolved in the soil solution due to the mass flow of the solution, is represented by the first term within the outer brackets and the dispersion process is represented by the second term in the outer brackets in Eq. 2. Dispersion is thought to comprise of mechanical dispersion (which results from tortuous flow paths in pores and also from differential flow velocities in a pore due to higher frictional forces near the pore walls) and molecular diffusion (results from random thermal-kinetic motion caused by concentration gradients).

It must be noted that if the dispersion term is negligibly small [i.e., $D_h(\theta, v) = 0$] and the solute input is considered as from rainfall only [i.e., $J_s = Cp.P$, where P is the mean annual rainfall (m/y) and Cp is the mean annual chloride ion concentration in rainfall (mg/l)], then Eq. 2 becomes;

$$q_w = \frac{P \cdot Cp}{C_z} \tag{3}$$

Equation 3 can be obtained more easily by considering the chloride mass balance for the root zone [or more precisely for the zone up to the zero flux plane (ZFP) from the soil surface], equating chloride flux input to the soil surface to that of flux leaving the root zone as follows.

$$P \cdot C_p = q_w \cdot C_z$$

$$\therefore q_w = R_e = \frac{P \cdot Cp}{C_z} \tag{4}$$

Therefore, knowing the rainfall, concentration of chloride ions in rainfall and that of the unsaturated soil zone, it is possible to estimate recharge provided it can be shown that convection is the main mode of solute transport (or diffusion and dispersion can be ignored).

ASSUMPTIONS AND THEIR VALIDITY

In deriving Eq. 2 (or Eqs. 3 or 4), a number of assumptions were made. They are discussed in turn and the effect of deviations from the assumptions on the recharge estimatión is discussed.

Steady State Flow

One of the major assumptions in deriving Eqs. 2 (or 3) is the assumption of steady state flow. This means that both input and output solute flux in the unsaturated zone must be constant with time. Fig. 1 shows the chloride input with rain for 5 locations in Sri Lanka and Fig. 2 shows the chloride input flux in precipitation for Silsoe in UK. As seen from Figs 1 and 2 the input solute flux is not constant with time either for Sri Lanka or for Silsoe. Also Edmunds and Gaye (1994) report of chloride measurements in rainfall where they report annual chloride input fluxes of 505, 259 and 365 $g/m^2/y$ for the location Louga in north-west Senegal in 1988, 1989 and 1990 respectively. Also for the location Leona in the same area the corresponding fluxes have been 492 and 2967 $g/m^2/y$ in 1988 and 1989.

However, monthly rainfall and chloride data collected by Sukhija *et al.*, (1988), in Pondicherry in India (shown in Fig. 3) for a period of 6 years, show a similar chloride input flux in a year though the monthly input flux varies from year to year, except for years 1980 and 1981. The amount of chloride input flux ($g/m^2/yr$) is shown towards the top of graph in respective years in Fig. 3. It must be noted though that some of the monthly data have been estimated rather than measured, which also could be a reason for having similar annual chloride fluxes in the last 4 years.

Therefore, from the evidence available, it is concluded that chloride input flux from rainfall is not steady, both in Sri Lanka and in other parts of the world.

Assuming a non steady chloride input in using equation 4 to estimate recharge is crucial only if rainfall and chloride concentration in rainfall are available only for a short recent period (as it is not correct to equate chloride input flux of recent years with that of many tens or hundreds of years ago, if a steady state has not been reached), Therefore, if a number of years of rainfall chloride data are available, a chloride mass balance (equation 4) can still be carried out enabling recharge to be estimated even under non steady conditions.

One Dimensional, Vertical and Downward Flow in the Unsaturated Zone

Equation 2 (or 3) is strictly valid for one dimensional, vertical and downward flow of solutes in the unsaturated zone (Scanlon, 1991). Therefore, in applying this method it is necessary to make sure that vertical downward flow is the most likely mode of flow. It must be noted though that if an impermeable layer (especially lenses of clay) or highly

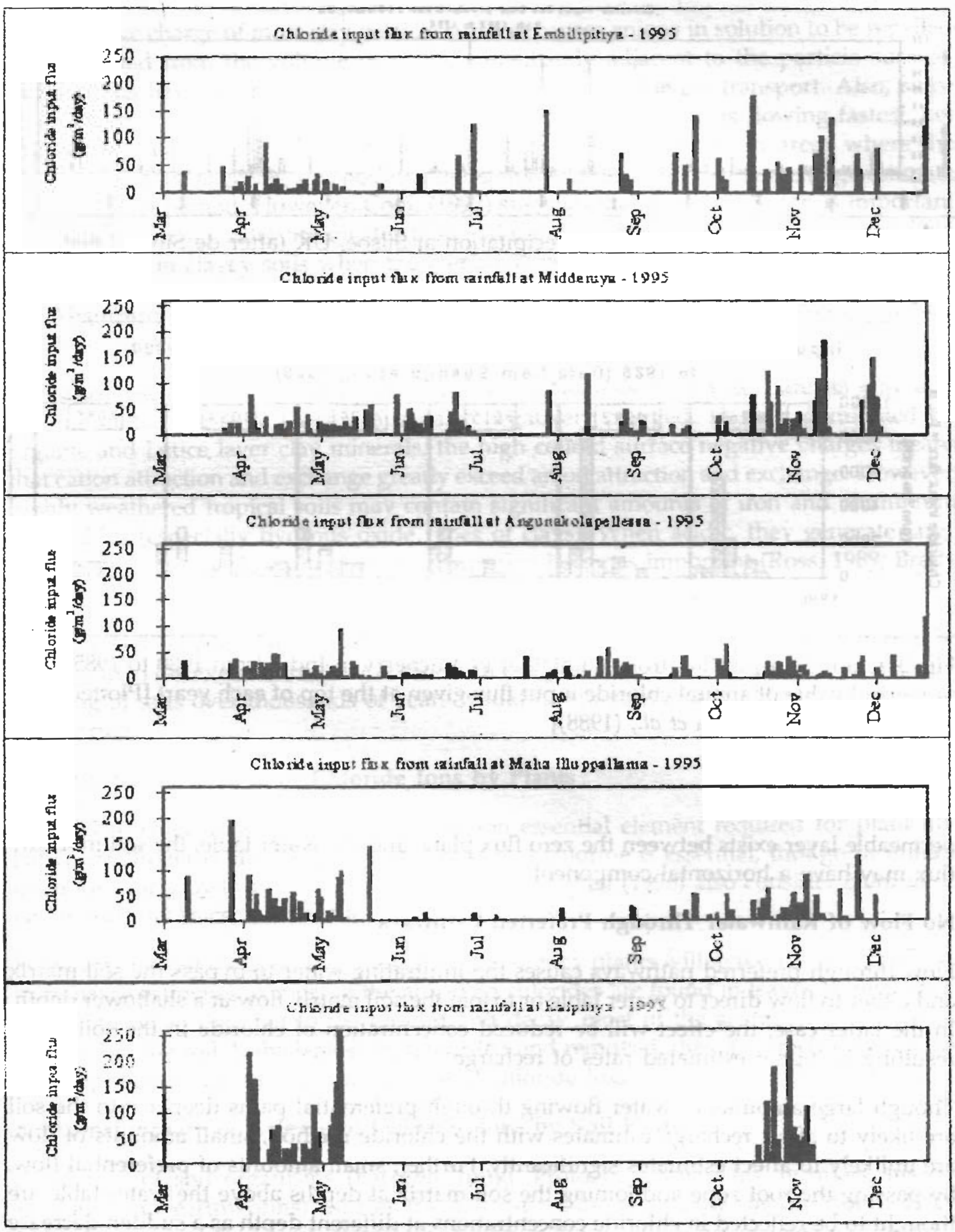


Fig. 1. Chloride input flux in rain at selected locations in Sri Lanka (after de Silva, 1996)

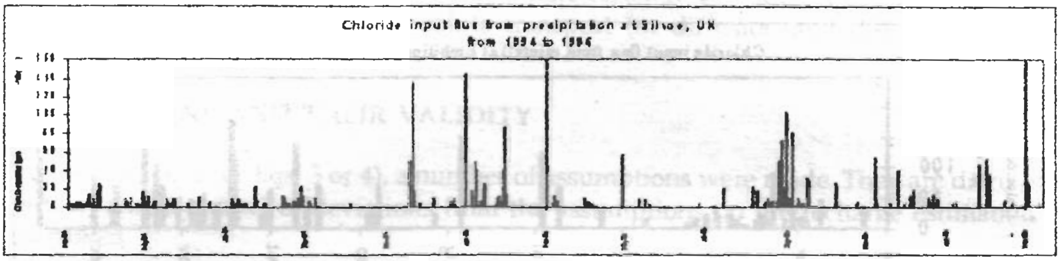


Fig. 2. Chloride input flux in precipitation at Silsoe, UK (after de Silva, 1996)

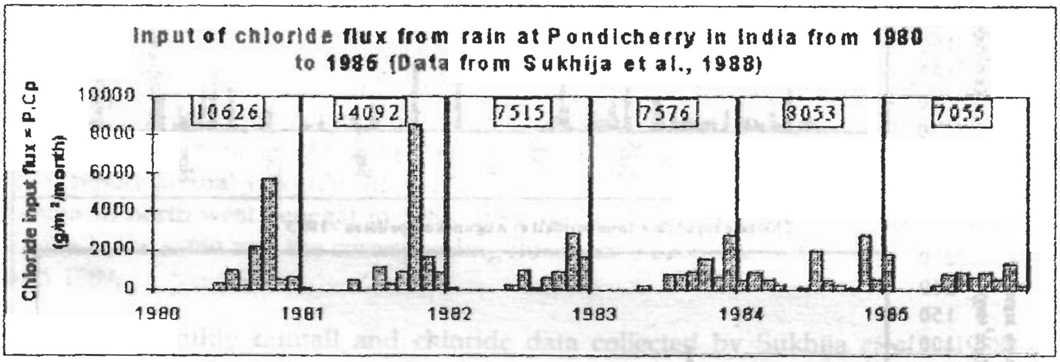


Fig. 3. Chloride input flux from Rainfall at Pondicherry in India from 1980 to 1985 (with numerical value of annual chloride input flux given at the top of each year) [Plotted from original data by Sukhija *et al.*, (1988)]

permeable layer exists between the zero flux plane and the water table, the soil moisture flux may have a horizontal component.

No Flow of Rainwater Through Preferred Pathways

Flow through preferred pathways causes the infiltrating water to bypass the soil matrix and either to flow direct to water table or to join the soil matrix flow at a shallower depth. In the latter case, the effect will be reduced concentration of chloride in the soil water resulting in higher estimated rates of recharge.

Though large amounts of water flowing through preferential paths deeper into the soil are likely to affect recharge estimates with the chloride method, small amounts of flow are unlikely to affect estimates significantly. Further, small amounts of preferential flow, by passing the root zone and joining the soil matrix at depths above the water table are thought to be reflected in chloride concentrations at different depth as a sudden decrease of chloride concentrations. If recharge estimates are to be closer to the actual recharge (which is what is required rather than the potential recharge), these flows also should be considered in the recharge estimation method, which the chloride method is capable of.

Negligible Anion Exclusion Effects

The negative charge of most clay particle surfaces causes anions in solution to be repelled and excluded from the volume of water immediately adjacent to the particle surface. Anions thus have a smaller effective water volume available for transport. Also, since anion concentration is highest in the centre of pores where water is flowing fastest, net anion flux can thus exceed net water flux (Ross, 1989). Therefore, in areas where the unsaturated zone is clayey, it is possible that anion exclusion affects the recharge estimate with chloride method. However, Cook (1992) suggests that anion exclusion is important only when recharge rates are greater than 100 mm/y. Hence, the method may be safely applied even in clayey soils when the climate is very dry.

No Absorption or Release of Chloride Ions by Clay Particles, Organic Matter or Soil Weathering Process

The most chemically (and physically) active components of any soil are its clay and organic matter content. These are usually negatively charged. In soils dominated by organic and lattice layer clay minerals, the high colloid surface negative charges means that cation attraction and exchange greatly exceed anion attraction and exchange. However, highly weathered tropical soils may contain significant amounts of iron and aluminium hydroxides (especially hydrous oxide types of clays). When acidic, they generate large amounts of positive charge and anion adsorption becomes important (Ross, 1989; Brady and Weil, 1996).

Johnston (1987a) cites a report where the chloride content of granitic rocks is found to be 0.18 kg/m^3. However, he thinks that this is an insignificant source of chloride. In any case leaching of salts over thousands of years would have removed any chloride released by weathering.

No Absorption/Release of Chloride Ions by Plants

Until 1954, chlorine was thought to be a non essential element required for plant life. However, Broyer *et al.*, (1954) demonstrated that chlorine is essential, though in minute quantities for growth in tomato plants. Brady and Weil (1996) also consider chlorine to be an essential micro nutrient for plant growth.

However, it is not thought that chloride absorption by plants will make a significant error in recharge estimates as most of the absorbed chlorides are found in leaves (Broyer *et al.*, 1954) and when they fall to the ground and decay, most of the absorbed chlorides are returned to the soil. If the leaves are harvested and removed, then a correction may have to be applied to account for the amount of chloride loss.

No Consumption or Release of Chloride Ions by Soil Fauna

A number of soil organisms (Bacteria, fungi, Protozoa, nematodes, termites, insects, molluscs and earthworms) inhabit the soil especially at shallow depth (Wood, 1989). However, none of the literature examined discuss the consumption or release of chloride by these soil fauna. In any case, the net contribution of chloride by fauna is likely to be negligible. However, in climates with marked seasons, the death of at least some species of organisms in one season and growth at a different season may affect the chloride ion concentrations of the soil (and thus recharge estimates).

In the case of taking soil samples to determine chloride concentration of soil water, a sample containing soil fauna (especially higher order ones like earthworms) may result in significantly higher chloride concentrations due to the release of salts upon death of such organisms during the process of soil water extraction. This is especially true in shallower depths (where chloride values are not required to estimate recharge), but, earthworms are known to burrow up to 2.5m (Wood, 1989).

No Removal of Chloride Ions by Soil Erosion

Soil erosion removes some of the top soil in thigh intensity rainstorms. Therefore some of the chloride ions infiltrated (particularly in a previous storm) could get washed away. Practically, however, the amount of chloride ions lost is likely to be negligible, and therefore, the effect of soil erosion is unlikely to cause a significant error in using the chloride method in the dry zone.

However, fertiliser which could contain chloride applied to uplands, could be washed away and get deposited in low lands and therefore the chloride method is more suitable for the areas where application and transport of fertiliser in uplands is unlikely.

No Sources of Chloride from Atmosphere Other than Rainfall

Atmospheric dust and also solid particles from meteors fall on earth. The former source is likely to be uniform (and therefore will be collected in rain gauges) and the latter source is not. However, the effect of meteors as a chloride source is thought to be negligible.

APPLICATION OF THE CHLORIDE PROFILING METHOD

The chloride profiling method has been used to estimate groundwater recharge in India (Sukhija *et al.*, 1996; Sukhija *et al.*, 1988), North America (Scanlon, 1991), Australia (Allison and Hughes, 1978; Sharma and Hughes, 1985; Cook *et al.*, 1989; Kennet-Smith *et al.*, 1994), Cyprus (Kitching *et al.*, 1980; Edmunds and Walton, 1980), Sudan (Edmunds *et al.*, 1988), Senegal (Edmunds and Gaye, 1994), United Kingdom (de Silva, 1999) and Sri Lanka (de Silva, 1998). From the available literature it is evident that Allison and Hughes (1978) in Australia, are the first to report using this technique to estimate recharge, although Peck and Hurle (1973) have considered a chloride balance of farmed and forested catchments in a study of land salinisation due to deforestation. However, Gardner (1967) has developed the theory of the method, which involves movement of solutes below the root zone.

Although the chloride method has been in existence only for about 20 - 25 years, it has been quite popular with the estimators of recharge in many parts of the world. This is possibly due to:

(a) The (apparent) simplicity of the chloride method, as often, the only parameters required to estimate recharge with this method are rainfall (usually available), chloride concentrations in rainfall (available some times) and depth profiles of chloride concentrations in soil (obtained by auguring and analysing for chloride can be done with basic analytical techniques).

(b) The chloride method estimates recharge averaged over a long period (a few years in wet tropical areas to hundreds or thousands of years in semi-arid and arid areas). From other methods, to get such an estimate would be impossible or monitoring over long periods are required. This is especially true in semi-arid and arid areas where the rainfall usually varies significantly with time.

(c) The relatively low costs involved in the process (especially if drilling is inexpensive) also contributed to its popularity. To analyse chloride in soil water, only very basic equipment is needed, which is available in most countries.

(d) The non requirement of estimating unknown parameters like the actual evapotranspiration and unsaturated hydraulic conductivity (which pose difficult problems).

Table 1 shows instances where estimates form unsaturated zone chloride profiling method have been verified from a different method by different researchers.

Table 1. Verification of recharge estimates by chloride profiling method with other methods by different workers

Country and Site	Rain mm/y	Epan mm/y	Soil	Vegetation	Recharge range (mm/y)	Method verified with	Source
Australia, SA	750	-	Sands over heavy clay, sandy clay, and limestone	-	50 - 70, 100, 100 -140, 105, 120	Tritium Profiles	Allison and Hughes (1978)
Australia, SA	750	-	Sands loam over limestone, Aeolianite, Skeletal soils		140 - 155, 195 - 200, 250 - 270	Tritium Profiles	Allison and Hughes (1978)
Australia NSW	310	2100	-	Cropping	6 - 9, 3 - 6, 4 - 32	Soil water balance	Kennet-Smith *et al.*, (1994)
Australia NSW	225	2200	-	Pasture	0 - 1	Soil water balance	Kennet-Smith *et al.*, (1994)
Australia NSW	430	1700	Clay	Cropping	3	Soil water balance	Kennet-Smith *et al.*, (1994)
Australia NSW	530	1500	Clay	Pasture	1 - 6	Soil water balance	Kennet-Smith *et al.*, (1994)
India, Pondicherry	1200	-	Sandy Alluvial deposits	-	220 - 260 100 - 140	Tritium Profiles	Sukhija *et al.*, (1988)

Note: A hyphen is shown where the relevant information is not reported.

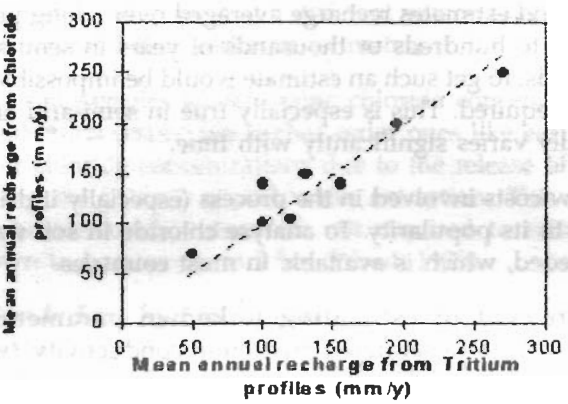


Fig. 4. Comparison of recharge estimates from chloride and tritium profiles [after Allison and Hughes (1978)]

Fig. 4 shows a comparison of recharge estimates by chloride method and tritium profiles, where the agreement is excellent.

From Table 1, the chloride method appears to have been successful in estimating recharge in a number of climates, soil and vegetation types. However, the verification in some cases had been carried out with the tritium profiling method, which is itself a tracer technique and therefore does not necessarily prove that the results of chloride method are reasonable. In other cases, the verification had been with a soil water balance method in semi-arid or arid climates where these models are likely to produce erroneous results.

CONCLUSIONS

From the above discussion, it is evident that the chloride profiling method is a simple, yet reasonably accurate method of estimating the groundwater recharge. The great advantage with this method is that unlike with other methods of estimating recharge, difficult-to-obtain-parameters such as hydraulic conductivity and actual evapotranspiration do not need to be obtained.

The method also seems to have worked in a range of climatic, soil and vegetative conditions (Table 1). Therefore, it is likely that the method will work in many situations provided that underlying assumptions are valid for these situations. If equation 3 or 4 is used to estimate recharge with this method (rather than equation 2), it is necessary to check if advection-dispersion of chloride ions in the particular condition can safely be neglected.

However, if the chloride profiling method is to be used effectively, records of long term chloride ion concentrations in rainfall is required. Therefore, responsible government agencies should measure and record this information at important locations.

REFERENCES

Allison, G.B. and Hughes, M.W., (1978), *The Use of Environmental Chloride and Tritium to Estimate Total Recharge in an Unconfined Aquifer*. Australian Journal of Soil Research, 16: 181-195.

Allison, G.B., Gee, G.W. and Tyler, S.W., (1994), *Vadose-Zone Techniques for Estimating Groundwater Recharge in Arid and Semiarid Regions.* Soil Science Society of America Journal, 58: 6-14.

Brady, N.C. and Weil, R.R., (1996), *The Nature & Properties of Soils* (11th edition). Prentice-Hall Inc., USA.

Bresler, E., (1973), *Transport of Salts in Soils and Sub Soils.* Agricultural Water Management, 4: 35-62.

Breyer, T.C., Carlton, A.B., Johnson, C.M. and Stout, P.R., (1954), *Chlorine - A Micronutrient Element for Higher Plants.* Plant Physiology, 29: 526-532.

Cook, P.G., Walker, G.R. and Jolly, I.D., (1989), *Spatial Variability of Groundwater Recharge in a Semi-Arid Region.* Journal of Hydrology, 111: 195-212.

Cook, P.G., Edmunds, W.M. and Gaye, C.B., (1992), *Estimating Paleorecharge and Paleoclimate From Unsaturated Zone Profiles.* Water Resources Research. 28(10): 2721-2732.

De Silva, R.P., (1996), *Estimating Groundwater Recharge in the Dry Zone of Sri Lanka with Special Emphasis on Spatial Variability.* Unpublished PhD Thesis, Silsoe College, Cranfield University, UK.

De Silva, R.P., (1998), *The Use of Environmental Chloride as a Tracer in the Unsaturated Soil Zone to Estimate Groundwater Recharge to the Dry Zone Aquifers of Sri Lanka.* Engineer, Vol: XXVII, No: 1 : 59-71, Journal of the Institution of Engineers of Sri Lanka.

De Silva, R.P., (1999), *Estimating the Rate of Recharge to the Groundwater Table Using Environmental Chloride as a Tracer.* Submitted for publication.

Edmunds, M.W. and Gaye, C.B., (1994), *Estimating the Spatial Variability of Groundwater Recharge in the Sahel Using Chloride.* Journal of Hydrology, 156: 47-59.

Edmunds, W.M. and Walton, N.R.G., (1980), *A Geochemical and Isotopic Approach to Recharge Evaluation in Semi-Arid Zones: Past and Present.* Proceedings of a Symposium on Arid Zone Hydrology Investigations with Isotope Techniques. IAEA, Vienna.

Edmunds, W.M., Darling, W.G. and Kinniburgh, D.G., (1988), *Solute Profile Techniques for Recharge Estimation in Semi-arid Terrain.* In: I. Simmers (ed.), Estimation of Natural Groundwater Recharge, 139-157, D. Reidel Publishing Company, Dordretch.

Gardner, W.R., (1967), *Water Uptake and Salt Distribution Patterns in Saline Soils.* Proceedings of a Symposium on Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul, 335-340, IAEA, Vienna.

Hendricks, J.M.H. and Walker, G.R., (1995), *Recharge of Phreatic Aquifers in Arid & Semi-Arid Areas.* In press.

Johnston, C.D., (1987), *Distribution of Environmental Chloride in Relation to Subsurface Hydrology.* In: A.J. Peck and D.R. Williamson (eds.), Hydrology and Salinity in the Collie River Basin, Western Australia. Journal of Hydrology, 94: 67-88.

Kennet-Smith, A., Cook, P.G. and Walker, G.R., (1994), *Factors Affecting Groundwater Recharge Following Clearing in the South Western Murray Basin*. Journal of Hydrology, 154: 85-105.

Kitching, R., Edmunds, W.M., Shearer, T.R., Walton, N.R.G. and Jacovides, J., (1980), *Assessment of Recharge to Aquifers*. Hydrological Science Bulletin, 25: 217-235.

Peck, A.J. and hurle, D.H., (1973), *Chloride Balance of Some Farmed and Forested Catchments in Southwestern Australia*. Water Resources Research, 9(3): 648-657.

Peck, A.J., Johnston, C.D. and Williamson, D.R., (1981), *Analyses of Solute Distributions in Deeply Weathered Soils*. Agricultural Water Management, 4: 83-102.

Ross, S., (1989), *Soil Processes: A Systematic Approach*. Routledge Publishers, London.

Scanlon. B.R., (1991), *Evaluation of Moisture Flux from Chloride Data in Desert Soils*. Journal of Hydrology, 128: 137-156.

Sharma, M.L. and Hughes, M.W., (1985), *Groundwater Recharge Estimation Using Chloride, Deuterium and Oxygen-18 Profiles in the Deep Coastal Sands of Western Australia*. Journal of Hydrology, 81: 93-109.

Sukhija, B.S., Reddy, D.V., Nagabhusshanam, P. and Chand, R., (1988), *Validity of the Environmental Chloride Method for Recharge Evaluation of Coastal Aquifers*. Journal of Hydrology, 99: 349-366.

Sukhija, B.S., Reddy, D.V., Nagabhusshanam, P. and Chand, R., Hussein, S., Giri, V.Y. and Patil, D.J., (1996), *Environmental and Injected Tracers Methodology to Estimate Direct Precipitation Recharge to a Confined Aquifer*. Journal of Hydrology, 177: 77-97.

Wood, M., (1989), *Soil Biology*. Blackie, Glasgow, UK.

HOW TO BUILD THE IMAGE OF YOUR INSTITUTION

*A.S.R. Rao**

The longer we live
The more we learn
It is not who has the most -
It is who makes the most of what he has.

- Unknown

ABSTRACT

In addition to their primary business of achieving academic excellence, technical institutions must also make continuous and conscious efforts to project their strengths and capabilities so that the nation at large may reap optimal benefits. The author's association of long years with the University of Roorkee, India, enabled him to crystallize his ideas on how to build the image of an institution and how this, in turn, would bring tangible benefits to both the institution as well as the nation.

INTRODUCTION

Technical institutions need huge man-power and financial resources for setting them up. It is, therefore, unpardonable if we do not let ourselves derive the maximum benefits out of these. And yet, for lack of dedicated efforts, we see several academically sound institutions not being able to make an impression in the minds of the public, thereby depriving themselves and the society of the fruits of their labour.

All technical institutions need to build their image at the regional and national levels so that –

- Their strengths and capabilities are recognized by the society.
- The user-industries and the society at large derive optimal benefits from them.
- They themselves get better inputs - better students seeking admission, better teachers wishing to join these institutions, better generation of revenues through consultancy and other services. In turn, these help enhance their capability for still better output.
- Those graduating from the institutions stand better chances of getting good placement.
- All concerned persons in the system, namely, the students, faculty, supporting staff and administrative staff may take legitimate pride in the glory of the institution, to which they would have, in some way, made a contribution.

IMAGE BUILDING - THE TASK OF EVERY PERSON

It goes without saying that image building should begin only after the institution achieves a level of excellence in all its programs and activities. Otherwise, it would be merely fooling the public and a dishonest endeavour, not worthy of an academic institution. In

* Professor, Nepal Engineering College

order that this prerequisite is achieved, there has to be a concerted effort from each and everyone concerned with the institution. The management should provide good leadership and support, the staff - both academic and nonacademic - must be committed to the cause and cooperate fully, and the students disciplined and dedicated.

Each one, big or small, belonging to an institution, must ask himself this question before he commits himself to an act. "Does this act of mine has the potential to bring down the image of my institution ?" Unless the answer in his own mind is an unambiguous "no", he should desist from his action.

However, achieving a modicum of excellence by itself is not sufficient. You need to make this fact known to the outside world. Indeed, some 'drum-beating' is not only necessary, but justified too. As they say in Texas, "If you have done it, it ain't bragging !".

HOW DOES ONE GO ABOUT IT ?

Some of the steps that should help project the strengths and potential of the institution and build its image, are :

- Highlighting achievements of the faculty, students and alumni and the capabilities of the institution through print media, radio and television.
- Forums such as students' association, faculty association and teacher - parent interaction can be used as platforms in projecting the right image.
- Experts from the industry, professional bodies, government and other agencies must be invited to help not only in the planning and development process but also in the academic activities of the institution. Technical education is too important to be left solely to the academics !
- Use of mass-media such as newspapers, magazines, radio, T.V. etc. to project the facilities, activities, innovations, achievements and future plans of the college.
- Arranging exhibitions and open houses for the public on occasions such as 'Founding Day', bring immense goodwill.
- Organizing special functions to mark the achievements of staff and students.
- Encouraging faculty to get into national level committees.
- Inviting distinguished, charismatic public persons to the campus for close-quarter interaction with students/faculty.
- Supporting cocurricular and extracurricular activities of students and encouraging the college teams to participate in worthwhile competitions outside. Student bodies such as the Literary and Debating Society, Sports Council, Music, Fine Arts Club, Hobbies Club can go a long way in moulding a student's personality and their achievements would, in turn, bring credit to the institution.
- Supporting participation of faculty in seminars, workshops, conferences and other programs organized by professional societies, industry, government and other agencies

will project the strengths of the institution and generates goodwill. The faculty will also develop self-confidence in the process.

- Providing extension and support services like -
  - Consultancy and Testing
  - R & D support to the industry
  - Continuing education cell
  - Community service activities such as adopting villages, environment protection, contribution to blood-bank, adult literacy program, etc.

  Such activities bring the college community into close contact with the ordinary public and professionals alike and help shed the 'ivory-tower' attitude.

- Setting up/strengthening the Alumni Association. Old students are real assets for any institution. They are ambassadors of goodwill and can be of great help in raising funds for endowments, research grants and for promoting institution - industry interaction.

IN CONCLUSION -

Even excellent institutions need to project and build their image in order to provide optimal service to the society and nation.

Image-building is the responsibility of everyone associated with the institution.

Building up a reputation for quality must precede efforts at image - building.

A multi-pronged approach must be adopted to project the institution's image.

If you wish to leave your footprints
On the sands of time,
Don't drag your feet.

ACKNOWLEDGMENT

This article is based on the lecture delivered at the ISTE nec Chapter in their series of 'Special Lectures'. The author is grateful to ISTE, nec Chapter for inviting him to deliver the lecture.

Call for Articles

Nepal Engineering College invites for its July 2001 Edition of SCITECH Nepal journal articles on topics related to Science, Engineering and Architecture from teachers, experts and field practitioners. The articles must be original and must not have been published earlier. The maximum length of papers shall be 2500 words or 10 typewritten pages, including references. An abstract must be sent along with the paper. The article may also be sent in a computer diskette. The articles will be reviewed and only accepted articles will be published. Rejected articles will not be returned to the authors except for original illustrations. Author/s will be paid an honorarium for accepted papers.

Authors may send their papers, along with the address for correspondence to :

The Editor,
SCITECH Nepal
Nepal Engineering College
Changunarayan, Bhaktapur
G.P.O. Box 10210

The last date for the receipt of articles is June 30, 2001. For a typical format of an article, the author is advised to refer to SCITECH Vol. 5 No. 2.