第５章　総括及び提言

５－１　総　括

５－１－１　セネガル

「Gorom Lampsar 川水系管理のための関係者間対話ネットワーク」の構築というアクションプランの実現がどこまで行われているかをみるのが今回のセネガルでのフォローアップの第一の目的であった。3 年間にわたる本邦研修の過程で、最終的にこのネットワークのイニシアティブは流域の水管理の中心になっている SAED がとるべきである、という結論になり、もう一方の組織である国立公園局もそれに同意していた。しかし、SEAD としては、既に機能している水利用者委員会を利用した方が、効率的だと判断しアクションプランを進めていたことが明らかになった。SAED がそのなかで、アクションプランで問題となった環境面への対応を可能な限りとろうとする姿勢に転換していることが、研修の大きな成果といえるのではないかと思う。特に、新たに設立されたギエ湖の水管理公社に SAED から転じた帰国研修員が、ギエ湖の水管理について本邦研修で提案された「水系管理のための関係者間対話ネットワーク」を導入しようとしていることは喜ばしいことである。

また Djoudji 国立公園では、課題であった地元住民との協働を大きな活動目標にしており、特に、地域住民主導のエコツーリズムの促進という目標においては、3 年間で成果があったことが今回のフォローアップで確認できた。今後、課題となっているガマなど水草の効果的な利用のための技術開発や、一方では、水草繁茂の原因をつくっている Diama ダムの運用についても、その根本的な検討を SEAD が中心となって行うことができれば、本邦研修の成果を更に大きなものとすることができるだろう。（小野）

2009 年事前調査に訪れたときと比較すると、ダカール市内のインフラ整備の発達には目を見張るものがあり、特に道路網の整備のおかげで市内を抜ける道が一段と速くなった。また同時にサンルイにある SAED の本部が同市の郊外に新築の事務所を構えた。前述に報告したように 2010 年に新しい水路が完成したこと、デビ・チゲ地区の灌漑用設備が更新されたことなどサンルイにおいても着実にインフラ整備が促進されている。そういったなかで彼らが目標として掲げた委員会の設立、ステークホルダーの連携というアクションプランは課題解決ための 1 つの大切な視点であり、本邦滞在中に何度も国立公園局の職員と SAED の担当者がぶつかり合いながら作成した内容である。分野を超えて両者が話し合う場をもてたこと、滞在中に彼らが議論を重ねアクションプランを更新していったことは、セネガルチームが他の参加国とは異なり、得た大きな成果である。ただ今回の現地訪問のなかで、両者（国立公園局と SAED：帰国研修員たち）が同じ場で顔をそろえるという設定をしなかったことは、距離的なこともあったが最終的な仕上げをする機会として逸してしまったことは否めない。帰国後 SAED が中心となり、水管理体制を推進していっていることを今回確認できたが、今後関係者との話し合いがより必要と感じているのは彼ら自身である。両者が早急に解決したいとしている課題、水草の駆除に関する情報共有あるいはガマを利用した炭に関する技術開発も農民たち、地域住民に裨益するところが大きく、今後現存する水利用者委員会を利用して更に関係者間で協力を強化することが望まれる。（黒田）

５－１－２　マラウイ

今回のフォローアップにより、1 名を除いて、すべての帰国研修員と会って話すことができた

だけでなく、研修員の作成したアクションプランの現場を視察することができ、極めて有益であった。特に、アクションプランの対象地域であるシレ川下流の Chiromo-Bangula 地域については、1 月に起きたばかりの洪水の現場を指揮している帰国研修員や、浸水状況を見ることができ、今後、アクションプランを改善していくためには今回の洪水の原因や被害状況を綿密に調査する必要性、特に浸水深についてのデータは有効であることを伝えることができた。

また、マラウイ政府から要請のあった“Project for the Study on Development of the Sena Corridor in the Republic of Malawi”の報告書を参照できたこと、この調査で設置された水位観測のための標識などの継続的利用や、この調査で明らかにされた過去の水位・流量の関係などを今後のアクションプランの改善に役立てることが可能となった。

洪水被害の評価についても、単に被害額や被害人数を把握するだけでなく、どの地域がどこまで浸水したかという空間的な把握が今後の治水対策には重要であることを、帰国研修員だけでなく地元関係者にも認識してもらうことができたことで、非常に効果的なフォローアップになったと考えている。

Lilongwe では、半日の「GIS セミナー」を実施し、特にシレ川下流部の洪水対策や生態系保全に役立つ GIS や、リモートセンシングの手法を講義するとともに、洪水対策に有効な、洪水シミュレーションの手法を示すことができた。研修員のみならず、多くの関連する機関からの参加者があり、活発な質疑応答がなされ、教育的な効果も大きかったと思われる。GIS については、マラウイ側にもそれなりの専門家がいることが分かったが、設備的な面でダウンロードに時間がかかり、結局先端的な技術を使えないでいる状況を把握できた。（小野）

５－２　更新案件への改善点、提言（マラウイ）

本研修は、2009～2011 年の 3 年間にわたり、できるだけ同一の組織から研修員が参加し、研修成果を次年度の参加者に引き継ついでもらうことで、3 年間かけて 1 つのアクションプランを完成させるという新しい試みであった。マラウイ側からは、その条件どおり DoDMA から参加者が継続して派遣され、さらに 3 年目には有力な協力機関として灌漑・水開発省からも参加を得ることができ、洪水被害を効果的に軽減することを可能にするアクションプランが最終的に提案された。

しかしながら、組織が異なる場合の弱点も把握できた。研修員たちにとって、帰国後、日常の仕事に追われるなか、互いに連絡をとり共同して最終報告書を作成することは想像以上に困難なことであった。またアクションプランの活動内容を通常業務のなかでこなすのも個人的な手腕も問われ、研修員たちの負担となることも理解できた。したがって、研修員個人の努力のみならず組織的な関与が今後も望まれる。今回のフォローアップ調査中「GIS セミナー」で研修員が作成したアクションプランの内容を多くの関係者に周知できたことから、アクションプランを遂行することにより理解を得られるのではないかと期待する。

同時に、本邦研修においてアクションプランを作成する際に、帰国後の活動内容が組織的な理解を得られるかどうか、得られたなかで実施できる内容かどうか確認することが重要であることも再確認した。同じ国から参加者が 2 名いる場合は、帰国後の役割分担を本邦研修中に行うのも一考ではないか。

今回の「GIS セミナー」出席者からも質問があったように、JICA 研修に参加したいとの要望が多い。本研修は、2012 年から 2014 年まで更新されるが、マラウイからは引き続き 2 つの異なる部署（DoDMA 及び灌漑・水開発省）からの参加を予定している。しかし、帰国後提出される進捗報告

書の報告及び今回実施したセミナー参加者の声からも、多岐にわたる関係者に日本での技術的指導の場が提供されるべきと考える。GIS やリモートセンシングについても、コンピューターの処理速度が不十分であったり、ノウハウはあっても、実際に情報をダウンロードできていないというハード的問題もあるが、より具体的な手法を本邦で習得する意味は十分あると考える。

以上のことから、効果的な流域管理、洪水対策を実現するために、マラウイ側には更に多くを学びたいという強い要望があることが確認された。今後マラウイ政府から要請があれば国別研修の実施も視野に入れ、これまでの帰国研修員や今後参加する研修員とのより一層の連携をとる必要があるであろう。

また、今回のフォローアップ調査結果とあわせ、今後 3 年間実施されるフェーズ II でアクションプランの内容を更にバージョンアップすることにより、マラウイ側には WB など国際的ドナーに提案できる洪水対策案を作成することが可能であり、アクションプラン実現への近道となるであろう。今後の進展に期待したい。（小野/黒田）

付　属　資　料

１．帰国研修員リスト
２．面談者リスト
３．収集資料
４．セミナー配布資料

気候変動による洪水対策と生態系保全のための順応的流域管理コース参加リスト
（2009年～2011年）

1．セネガル

	研修員氏名	参加当時現職	最終学歴	来日日	帰国日
1	Mr. SARR Mignane	Deputy Commissionner/Langue de Barbarie National Park, Department of National Parks, Ministry of Environment and Natural Protection ('09)	MSc in Agroeconomics/National School Superior of Agriculture ('06-'09)	2009.08.15	2009.10.18
2	Mr. DIONGUE Abdou	Chief Deputy/National Parks Direction, Ministry of Environment ('10)	Engineering Diploma in Agronomy/National School of Agriculture ('07-'10)	2010.08.14	2010.10.16
3	Mr. SYLLA Cheikh Moukhtar	Assistant Conservative/Saloum Delta National Park, Ministry o Environment ('10)	Diploma in Engineering/Bambey Forestry School ('98-'00)	2011.06.11	2011.07.02
4	Mr. FALL Sidy	Water Management Program Officer/DAIH,SAED('03)	Master in Environment/University Gaston('03-'08)	2009.08.15	2009.10.18
5	Mr. SALL Djibril	Head/Division of Fields and Water Management, SAED ('09)	University Degree in Mathematics and Physics/Dakar University ('01-'02)	2010.08.27	2010.10.16
6	Mr. DIA Ousmane	Water Management Advisor/SAED, Ministry of Agriculture ('06)	Diploma of Civil Engineer in Hydraulic Constructions/ Romania Polytechnic School ('78-'83)	2011.06.11	2011.07.02

2．マラウイ

1	Mr. KAMANGA Bruno Kapunda	District Enviromental Officer/ Environmental Affairs Department, Ministry of Naural Resourses and Enviromental Affairs('07)	BSc in Enviromental Sciences/ University of Malawi('00-'05)	2009.08.18	2009.10.17
2	Ms. MHANGO Veronica	Relief and Rehabilitation Officer/ Department of Disaster Management Affairs('08)	BA in Public Administration/ University of Malawi('04-'07)	2009.08.15	2009.10.17
3	Mr. CHIUSIWA James Mika Killion	Cordinator for Disaster Preparedness Relief Rehabiliation, Department of Distater Management Affairs ('07)	MA in Development Administration / Australian National University,Australia ('96-'98)	2010.08.15	2010.10.16
4	Mr. NJOLOMA Henrie Manford	Water Resources Development Officer/Water Resources Department, Ministry of Irrigation and Water Development ('10)	PhD in Hydrology and Water Resource/Shimane University,Tottori University,Japan('06-'09)	2011.06.12	2011.07.02
5	Mr. NKHOMA Dyce Kapumula	Pricipal Relief and Rehabilitation Officer/Department of Disaster Management Affairs, Office of the President and Cabinet('09)	M.Ed in Education Planning Policy and Leadership/University of Massachussts,USA ('01-'02)	2011.06.12	2011.07.02

面談者リスト　セネガル

Follow-up Cooperation for Ex-Participants"Adaptive Watershed Management for Flood Countermeasures by Climate Change and Conservation of Ecosystem"
Training Program

Attendee List

Date	Name	Title	Organization
25.01.12	Mignane SARR	Conservateur AMP Cayar	DPN.
25-01-12	Cheikh Amadou DIALLO	Adjoint Conservateur Parc Djoudj	DPN / PNOD
25-01-12	Boucar Ndiaye	Conservateur du Parc National de Djoudj (PNOD)	DPN / PNOD
25-01-2012	Cheikh Moukhtar Sylla	Adjoint au Conservateur Parc National du Delta du Saloum (PNDS)	DPN / PNDS

セネガル

Follow-up Cooperation for Ex-Participants"Adaptive Watershed Management for Flood Countermeasures by Climate Change and Conservation of Ecosystem"
Training Program

Attendee List

Date	Name	Title	Organization
26/01/2012	Fall SIDY	Technical Manager	Office du Lac de Guiers (OLAG)
26/01/2012	SALL Djibril	Head of Division of Scheme and Water Management	SAED.
26/01/2012	DIA OUSMANE	Water Management Adviser	SAED

面談者リスト　　マラウイ

Follow-up Cooperation for Ex-Participants"Adaptive Watershed Management for Flood Countermeasures by Climate Change and Conservation of Ecosystem"
Training Program

Attendee List

Date	Name	Title	Organization
30/01/12	Veronica Mhango	Relief and Rehabilitation Officer	Department of Disaster Management Affairs
30/01/12	Dyce Nkhoma	Principal Relief & Rehabilitation Officer	Dept. of Disaster Management Affairs
30/01/12	Henrie Njoloma	Water Resources Officer	Water Resources Department

マラウイ

Follow-up Cooperation for Ex-Participants"Adaptive Watershed Management for Flood Countermeasures by Climate Change and Conservation of Ecosystem"
Training Program

Attendee List

Date	Name	Title	Organization
1/2/12	Selani Temba	Officer In Charge	Police
1/2/12	James Chiusing	Coordinator for Disaster Management	Department of Disaster Management Affairs, Lilongwe
1/2/12	Agnes Banda	Relief & Rehabilitation	Department of Disaster management Affairs Officer Lilongwe
1/2/12	Takaharu Kakimura	Deputy Leader	Civil Engineering Research Institute
1/2/12	Collins Chisomba	Station Officer	Chiromo Police
1/2/12	ANJOYA KANYARIVA	INFORMATION OFFICER	INFORMATION-MANA
1/2/12	HUMPHREY MAGALASI	Ass. Dist Disaster Risk Mgt Officer	Dept of Disaster Mgt Affairs
1/2/12	RONNET SIMWAKA	DISTRICT COMMISSIONER	NSANJE DIST. COUNCIL

Accès au Djoudj

Djoudj est accessible par voie terrestre, à partir de:

- Saint Louis (60 km);
- Rosso-via Ross Béthio (70 km),
- Diama (30 Km de pistes)

Aménagements touristiques

- **Réseau de pistes intérieures**
- **Nichoir des pélicans**: plus de 20 000 couples
- **7 Miradors** comme points d'observation particuliers de certaines espèces.
- **.Hébergement:**

⇨ Hostellerie du Djoudj

⇨ Campement touristique villageois (Njagabar)

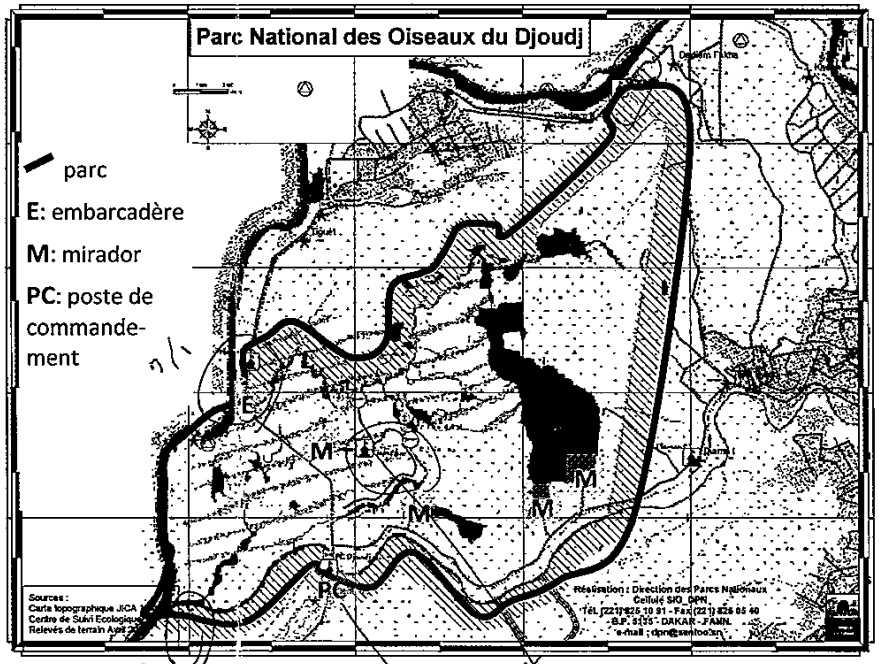
- **Boutique villageoise (Boutik Bi)**, à l'entrée du parc au niveau du Poste de Commandement: propose des souvenirs authentiques issus de l'artisanat local, et confectionnés par les femmes des villages périphériques.

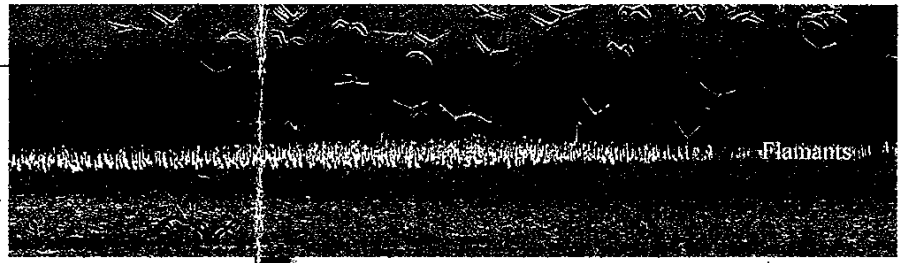
Tarifs

Permis de visite: 2000 F CFA /J/personne
Permis véhicule: 5000 F/ séjour
Balade fluviale: 3000 à 3500 FCFA/ Personne
Guidage: 10 000FCFA/J—5 000FCFA/½J

Renseignements

- Parc national des oiseaux du Djoudj, BP 80 Saint Louis-Sénégal
- Bureau d'information des parcs du Nord-Saint Louis, **tel (221) 33 961 86 21**
- Hostellerie du Djoudj , **tel (221) 33 963 87 02**
- Campement villageois Njagabar, **tel (221) 33 962 71 47**





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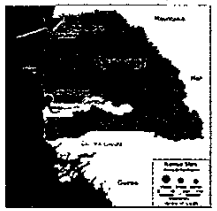


Parc national
Site Ramsar
Site du Patrimoine Mondial
Réserve de la Biosphère

Direction des parcs nationaux Sénégal
Tel: (221) 33 832 23 09
Fax (221) 33 832 23 11
Email: dpn@ornage.sn

Biodiversité et circuits touristiques

Situation

Dune superficie de 16 000 ha, le Parc national des oiseaux de Djoudj se localise au Nord-ouest du Sénégal, environ à 60 Km au Nord-est de la ville de Saint Louis.
Il est classé en 1971 avec comme objectif principal, la sauvegarde d'un échantillon de l'écosystème du Delta du fleuve Sénégal où séjournent des millions d'oiseaux migrateurs.

Le Djoudj est contigu au Diawling [illegible] nie, 2 parcs nationaux qui forment [illegible] transfrontalier écologiquement im[illegible] l'avifaune sauvage et classés Réser[illegible] phère.

Environnement humain

3 principales ethnies (Wolof, Maure, Peul) habitent les 7 villages de la périphérie immédiate du parc, pour une population d'environ 7 000 hbts. Elles ont comme activités essentielles l'élevage extensif, la pêche, le petit commerce, l' artisanat et l'agriculture avec un développement important de la riziculture irriguée.

Quelques dates repères

- **1971, création du Parc national**
- **[illegible]nt comme Zone Humide d'Im[illegible]ationale (site Ramsar)**
- **1981, Site du Patrimoin[illegible]al (UNESCO)**
- **2005, noyau de la Réser[illegible] de B[illegible]ère Transfrontière du Delta du F[illegible]ve Sénégal, entre le Sénégal et la Mauritanie.**

Richesse écologique

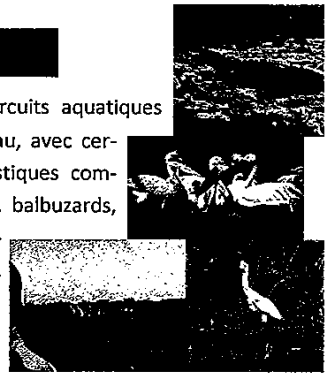
Les écosystème du Djoudj sont constitués de quelques dunes de sables et de plaines d'inondation, parcourues par un réseau de mares, marigots et lacs (lac Lamantin-1000 ha; Grand Lac-5500 ha; lac du Khar-1500ha). Dans ces écosystèmes, 121 espèces végétales, 92 espèces de poissons, 365 espèces d'oiseaux et plusieurs autres espèces de reptiles et de mammifères, sont recensées. En Afrique de l'Ouest, le Djoudj constitue:

- Première étape de la migration après la traversée du Sahara.
- Site d'hivernage pour près de trois millions d'oiseaux migrateurs d'Europe et d'Afrique. Les **pics sont atteints en janvier.**
- Site de reproduction du pélican blanc, du héron pourpré, du héron bihoreau, de la grande aigrette, de l'aigrette gazette, de la spatule d'Afrique...
- 3ème quartier d'hivernage des Anatidés (canards) en Afrique sub-saharienne, après le Delta intérieur du fleuve Niger et le lac Tchad.
- Fief de la plus grande colonie de pélicans blancs en reproduction (22 000 couples).
- Seule zone d'hivernage connue pour le Phragmite aquatique (*Acrocephalus paludicola*), passereau en voie de disparition nichant en Europe de l'Est (Hongrie, Pologne, Ukraine).
- Sanctuaire naturel pour des espèces locales telles que le lamantin d'Afrique, le crocodile du Nil, le python de séba, le phacochère, la gazelle à front roux, la gazelle dorcas, la grue couronnée.

Intérêt scientifique et pédagogique

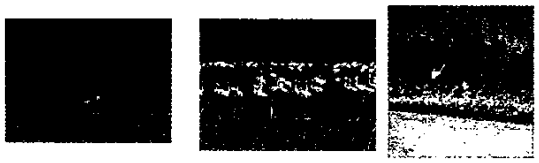
Le Djoudj possède des valeurs écologiques universelles. Situé dans la voie de migration des oiseaux d'eau ,il abrite au moins 1% de la population mondiale de plus 25 espèces d'oiseaux d'eau (critère Ramsar) et offre des spectacles assez originaux pour la découverte et l'éducation. La diversité et la dynamique de son environnement donnent des opportunités pour la recherche scientifique notamment avec sa station biologique

Produits touristiqu[illegible]



- **Ballade en pirogue:** circuits aquatiques (découverte du plan d'eau, avec certaines espèces caractéristiques comme les hérons, aigrettes, balbuzards, aigles, cormorans, anhingas, pélicans, crocodiles, phacochères, pythons...)

- **Safari véhicule:** circuits terrestres à la découverte de la grande faune du parc (phacochères, gazelles, grues couronnées, flamants pythons, chacals...) et des grandes concentration de canards dans les lacs.



- **Séjour en zone de terroirs (périphérie du parc):** découverte de la culture locale (habitat Maure, Peul, Wolof); des rizières

REPUBLIQUE DU SENEGAL
Un Peuple – Un But – Une Foi

MINISTERE DE L'HABITAT,
DE LA CONSTRUCTION ET DE L'HYDRAULIQUE

OFFICE DU LAC DE GUIERS
OLAG

Réf. : 223 /MHCH/OLAG/DG

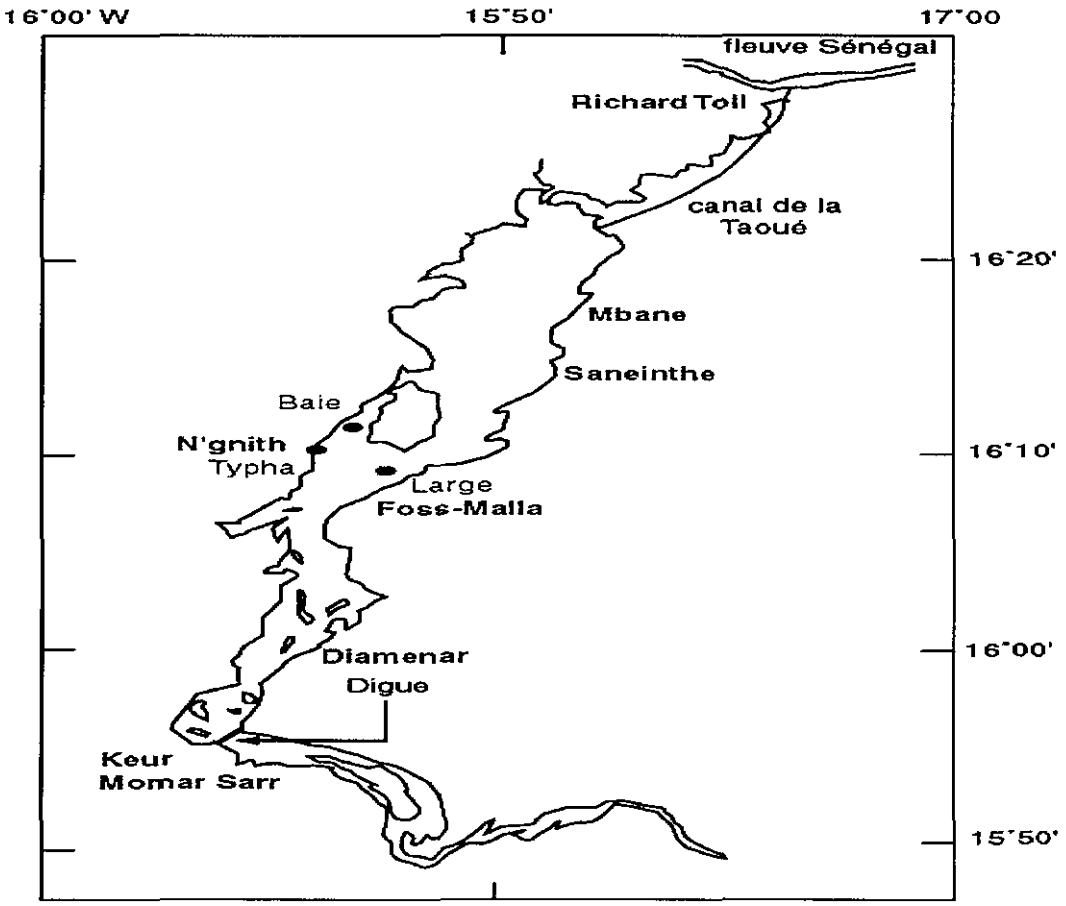
Saint Louis, le 12 octobre 2011

LE DIRECTEUR GENERAL

Objet : financement du Plan Triennal d'Investissement

Monsieur le Représentant Résident,

Le Lac de Guiers se trouve à environ 10 km au sud-ouest de Richard-Toll (ville de production sucrière du Sénégal) situé dans la région Nord du Sénégal. Le plan d'eau du Lac de Guiers s'inscrit dans un quadrilatère compris entre 15° 25' et 16° de longitude ouest et 15° 40' et 16° 25 de latitude nord. Il occupe le centre d'une vaste dépression naturelle de 50 km de long. La longueur du lac lui-même est de 50 km, sa largeur de 7 km en moyenne. Plat comme la plupart des lacs sahéliens, sa profondeur ne dépasse pas 2,5 m IGN. La profondeur moyenne est de 1,3 m. À la cote + 1 m, sa surface est de 240 km2 environ pour un volume moyen de 390/400 millions de m3. À la cote + 2, sa superficie atteint 300 km2 pour un volume de 600 millions de m3.



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Lac de Guiers joue deux fonctions essentielles dans le développement économique et social du Sénégal :

- Assurer l'approvisionnement en eau des villages riverains (100%), de Dakar (60%) et de l'ensemble des établissements humains situé tout au long de la conduite d'eau vers la capitale (100%) à travers une gestion qui garantie la qualité et la disponibilité de la ressource ;

- Garantir par une gestion appropriée le développement des activités agro sylvo pastorale notamment les conditions hydrologiques qui permettent la mise en valeur des 100.000 Ha en irrigation et en décrue, le développement de l'élevage et de la pêche dans le respect des équilibres entre la satisfaction des besoins présents et futurs.

Bien que stratégique dans la satisfaction des besoins en eau du Sénégal, la question de la préservation durable du Lac se pose présentement avec acuité, eu égard, d'une part, à la montée en flèche de la demande pour des usages de plus en plus diversifiés (irrigation, eau potable, pêche, etc.) et, d'autre part, aux risques de pollution et à l'utilisation anarchique de l'espace environnant.

Aux menaces qui pèsent sur la ressource du fait de la forte pression exercée par les différents usagers dans le processus de mise en valeur des 100.000 ha à vocation agricole qui le bordent s'ajoutent d'autres effets négatifs induits par des phénomènes naturels provoquant la salinisation, l'envasement, et d'importantes pertes. A cela s'ajoute le développement non contrôlé d'une végétation aquatique envahissante à effet nocif sur la ressource.

Le cumul de l'ensemble de ces paramètres crée une situation très inquiétante aggravée par :

- Une accélération du processus d'aménagement agricole des rives ;
- Une multiplication des formes d'usage de l'eau (alimentation en eau potable, irrigation, drainage) ;
- Une inquiétante dégradation de la qualité de l'eau du fait, entre autres, des rejets toxiques et de la prolifération de plantes aquatiques ; et
- Des risques de conflits liés au désir de plus en plus pressant des populations locales d'accéder à toutes les potentialités qu'offre le lac en particulier l'eau et la terre.

Afin d'éviter que le processus de dégradation du Lac de Guiers n'atteigne un seuil critique comme c'est le cas pour les autres Lacs d'Afrique au Sud du Sahara, le Président de la République à ériger la nécessité de sa gestion durable en priorité nationale avec la création de **l'Office du Lac de Guiers** dont la mission consiste, entre autres, à :

- Définir une politique de gestion intégrée des ressources en eau qui prend en compte l'exigence de la conservation et de l'utilisation rationnelle du Lac et de ses environs ;
- Elaborer un plan pour une gestion intégrée et durable des ressources du lac et de son environnement, sur la base d'une approche participative, multisectorielle et endogène ;
- Créer un système utilisateur pour une participation réelle des acteurs en renforçant la Cellule de Gestion du Lac de Guiers ;
- Sensibiliser tous les acteurs sur les avantages à tirer d'une gestion concertée et rationnelle du lac ;
- Créer une véritable organisation de la gestion de l'eau, avec des procédures pour clarifier les rôles, les interventions et un calendrier de manœuvre des vannes pour une planification des activités. Cette organisation devra faire l'objet d'une évaluation sur la base de paramètres et d'indicateurs précis.

Pour prendre en charge de manière effective de telles recommandations, la Direction Générale de l'Office du Lac de Guiers a élaboré le Plan Stratégique Triennal (2011 – 2013) ci-joint, structuré autour du «Programme de Gestion Durable des Réserves Stratégiques et Zones Humides du Lac de Guiers ».

Le coût global de ce PTI est estimé à seize (16) milliards environ pour la période 2011-2013. Pour son financement, l'Office est à la recherche de partenaires, dans la mesure où le budget de l'Etat ne contribue, présentement, que pour cinq cent (500) millions FCFA environ aussi bien pour l'investissement que pour le fonctionnement.

Au regard du rôle que la Coopération Japonaise joue dans le développement de l'Afrique en général et du Sénégal en particulier par le financement des programmes de développement, je souhaite vous rencontrer pour discuter des possibilités de collaboration entre nos deux institutions.

Dans l'attente d'une suite favorable à ma requête, je vous prie de recevoir, Monsieur le Représentant, mes salutations distinguées.

Cc : le Ministère d'Etat, Ministre de l'Urbanisme, de l'Habitat, de l'hydraulique et de l'Assainissement.

A

Monsieur le Représentant Résident
De la Coopération Japonaise à

DAKAR

OFFICE DU LAC DE GUIERS
La Direction Générale

RN2 Khor Saint-Louis Tél. : (221) 33 938 20 11 – Fax : (221) 33 961 77 95 – NINEA 4351805/0K0
email : officenationallg@gmail.com BP : 490 Saint Louis

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT AND PUBLIC INFRASTRUCTURE (MOTPI)
REPUBLIC OF MALAWI

PROJECT FOR THE STUDY ON DEVELOPMENT OF THE SENA CORRIDOR IN THE REPUBLIC OF MALAWI

DRAFT FINAL REPORT

PART II PRE-FEASIBILITY STUDY

JANUARY 2012

CENTRAL CONSULTANT INC.
NIPPON KOEI CO., LTD.
YACHIYO ENGINEERING CO., LTD.
TOSTEMS, INC.

ATKINS

Integrated Flood Risk Management Plan for the Shire Basin project

Inception Report

October 2011

Plan Design Enable

II

NSANJE DISTRICT COUNCIL **30th JANUARY 2012**

BRIEF SUMMARY OF FLOOD SITUATION

1.0 INTRODUCTION

On 7th January 2012, floods occurred in Traditional Authority (T/A) Mlolo where 1347 households were affected.

On 19th January 2012, floods occurred in Traditional Authority (T/A) Mbenje where 448 households were affected.

On 22nd January 2012, floods occurred in Traditional Authority (T/A) Mlolo again where 6159 people were displaced. which was more severe than the one that occurred on 7th January 2012.

2.0 DETAILS OF THE FLOOD DAMAGE

(a) 7th JANUARY 2012, T/A MLOLO

VILLAGES AND HOUSEHOLDS

No.	Group Vg Head (GVH)	No. of Vgs affected	No. of ~~H/Hs~~ ppl affected	Houses destroyed by floods	Houses flashed by floods	Number of Elderly affected	Number of Orphans affected	Number of toilets affected	Water points affected
1	Osiyana	11	574	8	574	79	51	297	8
2	Kalonga	21	1218	0	407	114	5	1	1
3	Sambani	9	575	0	83	60	52	0	0
4	Chitseko	6	122	0	54	21	29	0	0
5	Chipondeni	4	127	0	34	16	19	0	0
6	Mchacha James	33	736	4	195	128		2	6
Total		84	3352	12	1347	418	156	300	15

CROPS AND HECTARES AFFECTED

GVH	MAIZE		BRUSH MILLET		SORGHUM		COTTON	
	No. of people	Hectares	No. of people	Hectares	No. of people	Hectares	No. of people	Hectares
Osiyana	363	139.9	0	0	0	0	167	66.8
Kalonga	967	308.9	0	0	0	0	177	56.2
Sambani	575	105.4	0	0	0	0	8	2.1
Chitseko	29	9.0	23	7.3	24	11.0	47	38
Chipondeni	59	33.5	23	6	17	5.1	28	23.2
Mchacha James	499	134.2	12	1.2	84	29.8	544	230
TOTAL	**2492**	**730.9**	**58**	**14.5**	**125**	**45.9**	**971**	**416.3**

(a) 19TH JANUARY 2012, T/A MBENJE

GVH affected	Number of Villages	Houses flashed by floods	Houses destroyed by floods	Total houses affected	Total number of toilets	Water points affected
Nyang'a	8	26	44	70	86	-
Tambo	9	32	211	243	305	-
Kalenso	12	67	68	135	159	-
Ntchenyera	7	-	-	-	-	-
TOTAL	**36**	**125**	**323**	**448**	**550**	-

NB: Houses in GHV Ntchenyera were not affected by the floods but crop fields only. Agriculture extension workers are currently assessing the hectarage affected.

(b) 22ND JANUARY 2012, T/A MLOLO

1	**Date of disaster**	Sunday, 22nd January 2012	
2	**Type of disaster**	Flooding	
3	**Location of disaster**	Northern part of Nsanje District in South of Malawi. T/A Mlolo. Makhanga EPA.	
	SECTION	***REQUIREMENTS / FACTS***	***QUANTITIES / NUMBERS***
4	**Site information**	Men	813
		Women	1744
		Children	3602
		Total number of People in all camps	**6159**
	(Camps)	***Segregation / Gender***	
	Makhanga Primary School	Women	33
		Men	8
		Children	31
		Total Number	**82**
	Agriculture EPA.	Women	25
		Men	6
		Children	15
		Total Number	**46**
	Mchacha James	Women	33
		Men	14
		Children	13
		Total Number	**80**
	Islamic Boarding School	Women	
		Men	
		Children	
		Total Number	**35**
	Kadyamba Camp	Women	450
		Men	83
		Children	277
		Total Number	**760**
	Bangula Council Resthouse and Admarc	Women	125
		Men	83
		Children	142
		Total Number	**350**
	Osiyana Camp	Women	977
		Men	655
		Children (Boys 1200, Girls 2054)	3254
		Total Number	**4886**
5	**Population Description**	Men, Women, Elderly, children	
6	**Education**	Schools affected	Namiyala Chikonje

3.0 NEEDS /GAP ANALYSIS

required

SUMMARY OF REQUIREMENTS RELIEF ITEMS AND FACILITIES FOR FLOOD AFFECTED HOUSEHOLDS															
	OSIYANA			MCHACHA JAMES			KADYAMBA			BANGULA			MAKHANGA		
REQUIREMENTS	POP	REVD	REQD	POP	REVD	REQD	POP	REVD	REQD	POP	REVD	REQD	POP	REVD	REQD
FOOD															
Maize	4886	0	1814	80	50	80	760	385	375	350	100	208	82	50	41
Flour	4886	142	837	80	81	47	760	0	0	350	286	530	82	45	44
Beans	4886	17	195	80	16	10	760	18	25	350	42	70	82	8	16
Salt	4886	7	300	80	5	8	760	9	52	350	29	32	82	3	10
Blankets	4886	176	1456	80	80	80	760	500	260	350	300	50	82	82	82
SANITATION															
San plats	4886	15	115	80	10	10	760	0	20	350	0	10	82	3	8
Buckets	4886	176	815	80	45	45	760	0	760	350	150	200	82	39	43
S. Kit	4886	97	977	80	47	47	760	56	760	350	250	350	82	44	4
Tents	4886	2	97	80	2	3	760	0	0	350	0	0	82	0	0
Tarpaulins	4886	0	1638	80	0	47	760	0	760	350	0	350	82	0	42
Plastic sheets	4886	8	450	80	5	30	760	3	55	350	6	35	82	6	28
OTHERS															
Soap	4886	0	500kgs	80	0	20kgs	760	0	200kgs	350	51kgs	150kgs	82	0	20kgs
Sugar	4886	0	1000kgs	80	0	100kgs	760	0	760kgs	350	0	350kgs	82	0	100kgs
Cook Oil	4886	0	1500lts	80	0	80lts	760	0	800lts	350	0	400lts	82	0	45lts
L. Phala	4886	0	3254kgs	80	0	40	760	0	1250kgs	350	0	1500kgs	82	0	40kgs
Candles	4886	0	350pkts	80	0	20pkts	760	0	120pkts	350	0	300pkts	82	0	20pkts

			Muona Makhanga Chikali
		Tents / Shelters required	
		Available tents	6 (unicef)
7	**Shelters**	In 5 Camps	
		Total shelters	17 (shelters)
8	**Food**	Population	6159 (people)
		Maize flour / grain	95,850 kgs (95.9 mt) 100 metric tonne of Maize
		Beans	9585 kgs (9.6 mt) 10 mt of Beans
		Salt	4,478kgs (4.0 mt)
9	**Livelihoods / Agriculture**	Not assessed	
		Seeds /fertilizer to replant	
		Seeds /fertilizer for winter cropping	
		Hoes	
10	**Water and Sanitation**	Safe water	1 Water jetting pumps in Osiyana camp
		Repairing and maintenance of boreholes	
		Toilets	237 drum toilets 237 san plats
		Plastic sheeting	4740 metres
11	**Medical Supplies**	ORS	10000 Sachets
		Lingers lactate (IV Fluids)	2500 litres
		Tents	7
		20 litres bucket with caps	70
		20 litres bucket without caps	70
		5 litres bucket	140
		Giving sets	1600
		Cannulae	2000
		Bars of soap	140 kgs
		Soap powder	140 kgs
		Chlorine	500 kgs
		Gumboots	140 pairs
		Plastic sheets	30 rolls
		Disposable aprons	20 bundles (50 each)
		Face mask	500
		Gloves	100 (50 pairs)
		Sensitization	
12	**Other Requirements**	Bars of Soap	1000 kgs
		Matches	150 boxes (10 each packet)
		Candles	300 packets (6 candles each)
		Sugar	20 bales (20 each bale)
		Protective cloths	

4.0 PRIORITY RELIEF ITEMS / NEEDS

CAMP	ITEMS
Osiyana	Maize flour /grain
	Additional toilets
	Provision of water
	Survival kits
	Essential drugs
	Blankets
	Utensils
	Disinfectants / Chlorine
	Likuni phala
	Beans / Relish
	Cooking oil
Bangula Camp A and B	Maize flour /grain
	Additional toilets
	Survival kits
	Essential drugs
	Blankets
	Utensils
	Disinfectants / Chlorine
	Likuni phala
	Beans / Relish
	Cooking oil
Kadyamba	Maize flour /grain
	Additional toilets
	Provision of water
	Survival kits
	Essential drugs
	Blankets
	Utensils
	Disinfectants / Chlorine
	Likuni phala
	Beans / Relish
	Cooking oil
Mchacha James	Maize flour / grain
	Additional toilets
	Provision of water
	Survival kits
	Essential drugs
	Blankets
	Utensils
	Disinfectants / Chlorine
	Likuni phala
	Beans / Relish
	Cooking oil
Makhanga	Maize flour / grain

Mosquito nets

	Additional toilets
	Provision of water
	Survival kits
	Essential drugs
	Blankets
	Utensils
	Disinfectants / Chlorine
	Likuni phala
	Beans / Relish
	Cooking oil

Please Note:

As per assessment done and tour that took place on Tuesday 31st January 2012 following observation and resolutions were made.

(1) Mchacha James camp flood victims have gone back to their homes and assistance will be provided through their leaders.

(2) Makhanga camp will also disband and assistance will be provided through their village leaders.

More assistance is required to enable flood affected households resettle and for life to return to normarcy

Unisef
district

5.0 SUMMARY OF SUPPORT RECEIVED T/A MLOLO

Goods / Items Received	Quantity	Source
50kg bags of maize	1359	Department of Disaster Management Affairs
20kg bags of Cream of Maize	700	
50kg bags of beans	136	
Blankets	2718	
Plastic pails with taps	1359	
Plastic cups	6795	
Rolls of plastic sheets	136	
20kg bags of salt	68	
Rectangular Tent (24 square metre)	8	
Rectangular Tent (72 square metre)	6	
5kg bags of cream maize	323	Sisters of Divine Province
Spoons	60	Unicef
Big basins	12	
Small basins	12	
Water mug	12	
Emergency Survival kits	800	
Tarpaulins 4x6 each	800	Malawi Red Cross Society

6.0 SUMMARY OF SUPPORT PLEDGED

SECTOR / INST. ORG	SUPPORT PLEDGED	QUANTITY
Medicin San Fronteers (MSF)	Sanitation facilities	
	Water filters	
	Tents	
Plan Malawi	Likuni Phala	
	Plastic sheets	
Act Alliance	**Food and Nutrition**	
	Maize flour	30MT for three months
	Kapenta fish	3MT for three months
	Cooking oil	4520 litres for three months
	Beans	3MT for three months
	Shelter and Protection	
	Plastic sheets for rebuilding	
	Tents	
	Blankets	500
	Water and Sanitation	
	Water purifying machine	1 unit
	Toilet plastic platforms	100 pieces
	Chlorine	50kg

7.0 CHALLENGES

Delayed detailed assessment due to accessibility
Scattered camp sites.
Delayed logistical support.

8.0 RECOMMENDATIONS

Civil Protection Committees should speed up detailed assessment
Improve communication between district and local structure
Decentralise financial resources.

9.0 CONCLUSION

Relief items may be required for the next two to three months because people may not return to their homes due to fear of flood incidences eg Bangula and Dsiyana Camps

GIS SEMINAR -2012-

Date:	February 2, (Thursday)
Venue:	Tikwere House where the Water Resources Department
Participants:	Concerned officials of (i) Department of Disaster Management Affairs (ii) Department of Water Resources (iii) Flood Control Countermeasures
Purpose:	Better understandings of introduction on GIS as a tool for collecting data "Case study on the Lower Shire Area, Southern Malawi"
12:45-13:00	Registration
13:00-13:05	Introductory Remarks by JICA Obihiro
13:05-13:35	Introduction of JICA Group Training in Japan "Adaptive Watershed Management for Flood Countermeasures by Climate Change and Conservation of Ecosystem" (by Dr. Yugo ONO, Program Leader, Professor of Hokkaido University)
13:35-15:00	Lecture: "Introduction of GIS and Remote Sensing as a tool of analysis of flood Control through –the case study of Lower Shire area, Southern Malawi" (by Dr. Buho HOSHINO, Professor of Rakuno Gakuen University)
15:00-15:15	Tea break
15:15-15:45	Q & A
15:45-16:15	Necessary survey and advice on flood control plan in the Lower Shire, Southern Malawi (by Mr. Takaharu KAKINUMA, Deputy Team Leader, Civil Engineering Research Institute)
16:15-16:30	Q & A
16:30-16:45	Wrap up of the Seminar by Dr. ONO

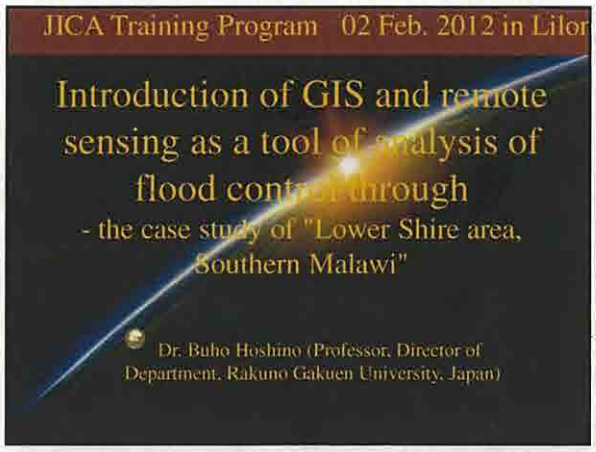
End

Introduction of GIS and remote sensing as a tool of analysis of flood control through
- the case study of "Lower Shire area, Southern Malawi"

Dr. Buho Hoshino (Professor, Director of Department, Rakuno Gakuen University, Japan)

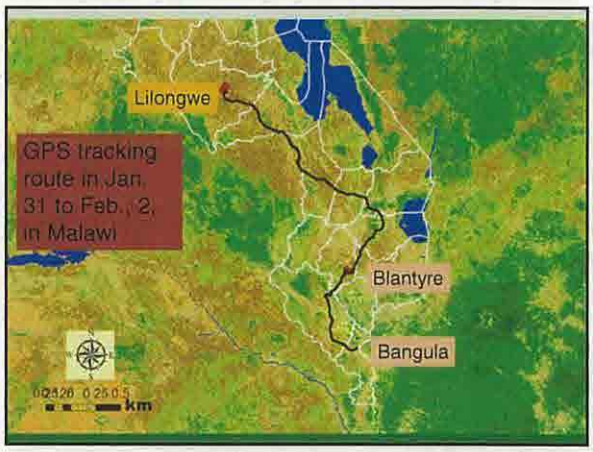
Floods are among the most devastating natural hazards in the world, widely distributed leading to significant economic and social damages than any other natural phenomenon. Each year they cause considerable damage to people's lives and properties. To contribute for the development of geospatial database and knowledge system for planning and management of river basin systems in the context of integrated flood damage assessment. Increase local capacity and expertise in new remote sensing technologies for effective and integrated river basin management. Remote sensing and GIS technologies are excellent tools in the mapping of the spatial distribution of disaster related data within a relatively short period of time. Applications of using data from satellites to predict weather-related disastrous phenomena, such as extreme storms and rainfall, are widely known and frequently utilized. Satellite data can be used before, during and after a disaster, for prevention, monitoring, mitigation and relief operations, respectively. Areas affected by flooding are typically large in size. Many different types of flooding occur, each with different requirements for satellite imagery. Two general categories are first, river floods, which can be seasonal and are related to big rivers or flash floods in smaller catchments, and second, coastal floods, frequently related to tropical cyclones or to high tides. Flood monitoring should supply real time information for local relief efforts; therefore data with high spatial and temporal resolution is needed. Depending on the requirements, temporal analysis of the flood requires high temporal resolution, detailed spatial analysis high spatial resolution, the optimum sensors or sensor combination should be used.

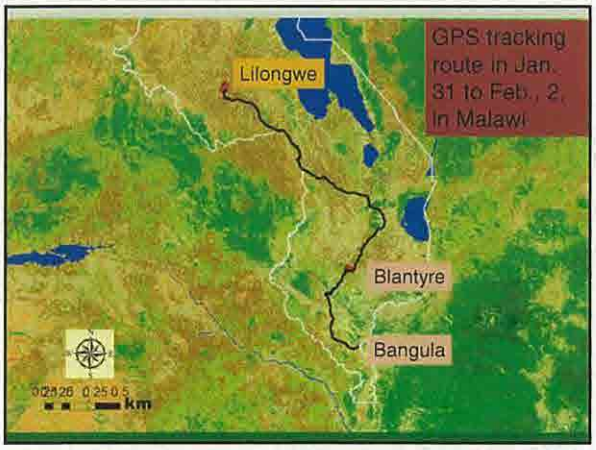
We need to develop a decision support system for flood prediction and monitoring that integrates hydrological modeling and GIS. Usually, hydrological models have been used to calculate hydrological parameters of a flood such as water depth, flood wave velocity etc. to estimate flood hazard. Remote sensing technology along with geographic information system (GIS) has become the key tool for flood monitoring in recent years. Metrological satellite or Earth observation satellite (such as NOAA, MODIS), microwave satellite (such as SAR) and digital elevation model (DEM) to classify flood hazard and flood risk zone. However, DEM was used to classify water depth on remote sensing data instead of calculating water depth from DEM directly because of the coarse resolution of DEM. In this study, we introduce the free satellite data and DEM file were how to extract water depth using GIS tools.


JICA Training Program 02 Feb. 2012 in Lilor
Introduction of GIS and remote sensing as a tool of analysis of flood control through
- the case study of "Lower Shire area, Southern Malawi"
Dr. Buho Hoshino (Professor, Director of Department, Rakuno Gakuen University, Japan)


Lilongwe
Blantyre
Bangula


GPS tracking route
Lilongwe
Blantyre
Bangula


Lilongwe
GPS tracking route in Jan. 31 to Feb., 2, in Malawi
Blantyre
Bangula


Lilongwe
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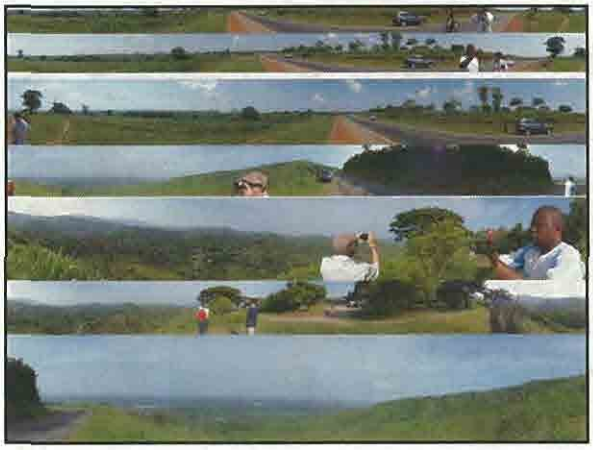
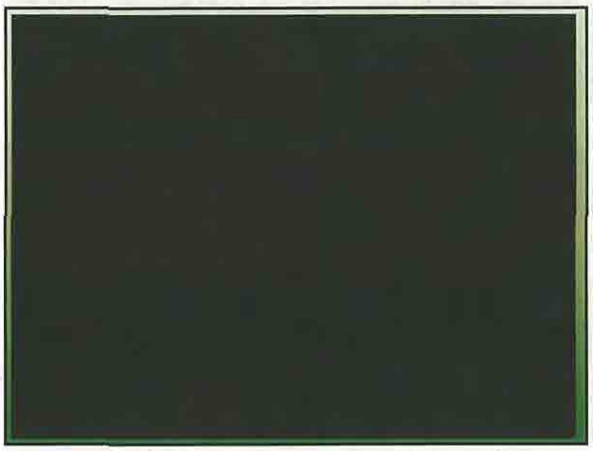
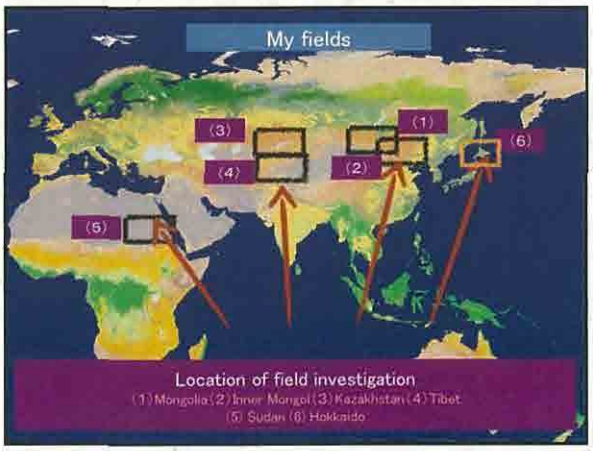





WEBSITE
TOP
Environmental Remote Sensing Laboratory,
Rakuno Gakuen University, Japan
研究内容
エクステンション活動
ゼミ生紹介
ゼミ活動
論文・著書
記事・テレビ放送
写真
リンク集
Buho Hoshino Labratory (Lab. of Env. RS)
Rakuno Gakuen University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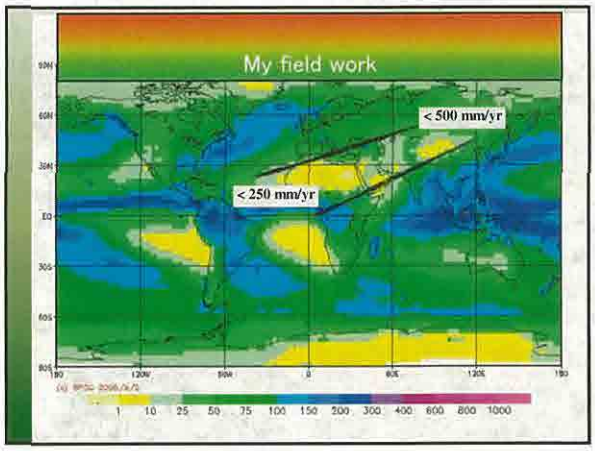
Location of field investigation
(1) Mongolia (2) Inner Mongol (3) Kazakhstan (4) Tibet
(5) Sudan (6) Hokkaido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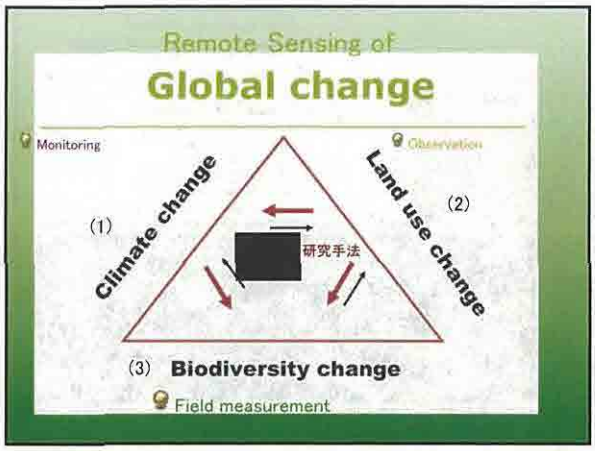
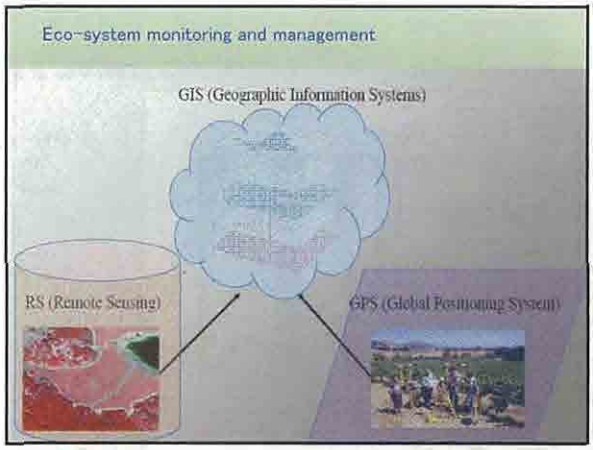
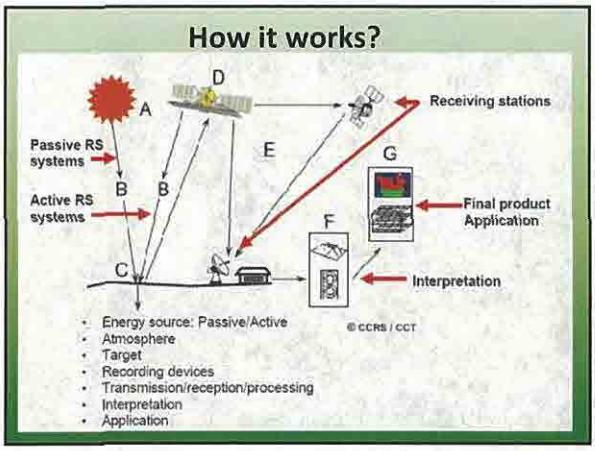
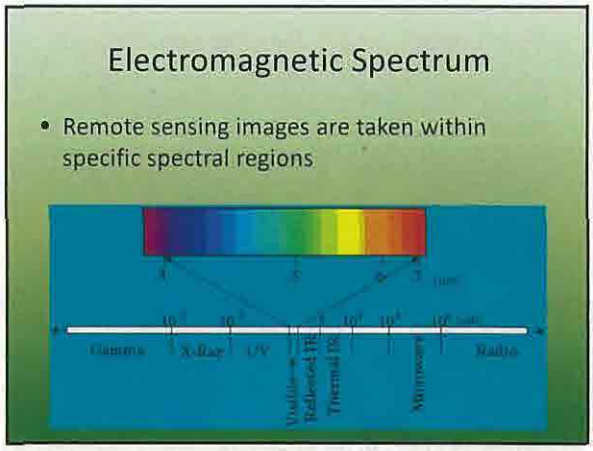
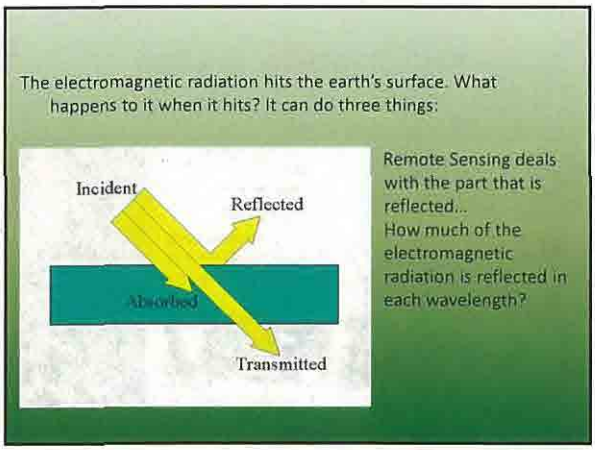
< 250 mm/yr
1 10 25 50 75 100 150 200 300 400 600 800 1000

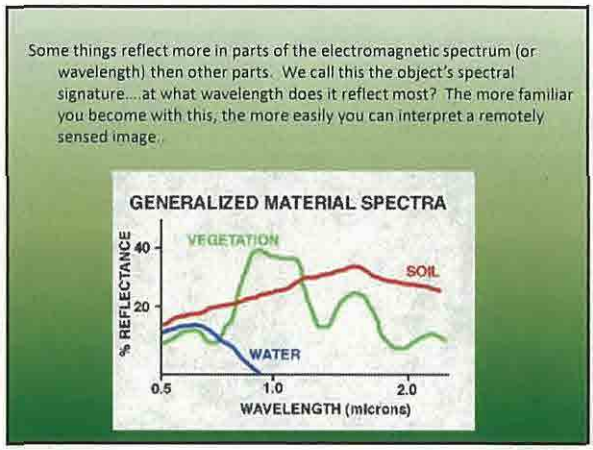

Remote Sensing of
Global change
Monitoring
Observation
(1)
Climate change
Land use change
(2)
研究手法
(3) Biodiversity change
Field measurement


Eco-system monitoring and management
GIS (Geographic Information Systems)
RS (Remote Sensing)
GPS (Global Positioning System)

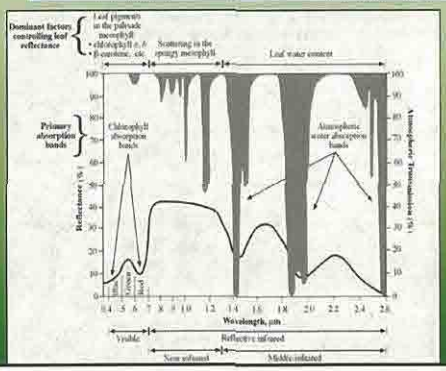

How it works?
A
B
B
C
D
E
F
G
Passive RS systems
Active RS systems
Receiving stations
Final product Application
Interpretation
© CCRS / CCT
Energy source: Passive/Active
Atmosphere
Target
Recording devices
Transmission/reception/processing
Interpretation
Application


Electromagnetic Spectrum
Remote sensing images are taken within specific spectral regions
Gamma
X-Ray
UV
Visible
Reflected IR
Thermal IR
Microwave
Radio

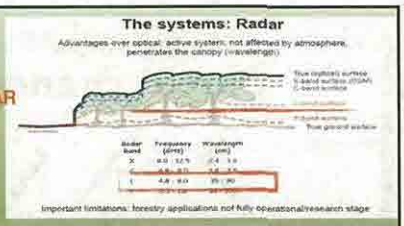

The electromagnetic radiation hits the earth's surface. What happens to it when it hits? It can do three things:
Incident
Reflected
Absorbed
Transmitted
Remote Sensing deals with the part that is reflected...
How much of the electromagnetic radiation is reflected in each wavelength?


Some things reflect more in parts of the electromagnetic spectrum (or wavelength) then other parts. We call this the object's spectral signature....at what wavelength does it reflect most? The more familiar you become with this, the more easily you can interpret a remotely sensed image.
GENERALIZED MATERIAL SPECTRA
% REFLECTANCE
40
20
VEGETATION
SOIL
WATER
0.5
1.0
2.0
WAVELENGTH (microns)

Dominant Factors Controlling Leaf Reflectance



The systems: Radar

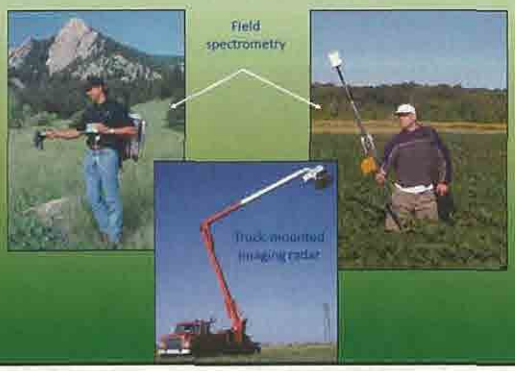


The L-band microwave PALSAR sensor are penetration into vegetation.

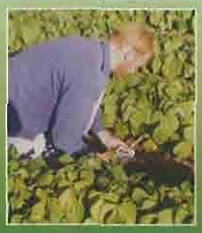
Suitability of different microwave sensors for soil moisture retrieval. low frequency microwave measurements are known to be beneficial for soil moisture retrieval due to their capability to better penetrate vegetation (top) and the high sensitivity to the dielectric constant of the wet soil (second from top)(Wagner et al. 2007).

1. Traditional Remote Sensing Applications

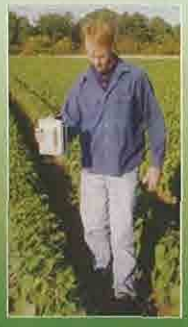
Vegetation (bio-geography)



In situ Measurement in Support of Remote Sensing Measurement



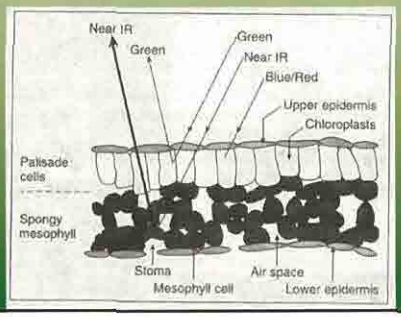
In situ ceptometer leaf-area-index (LAI) measurement



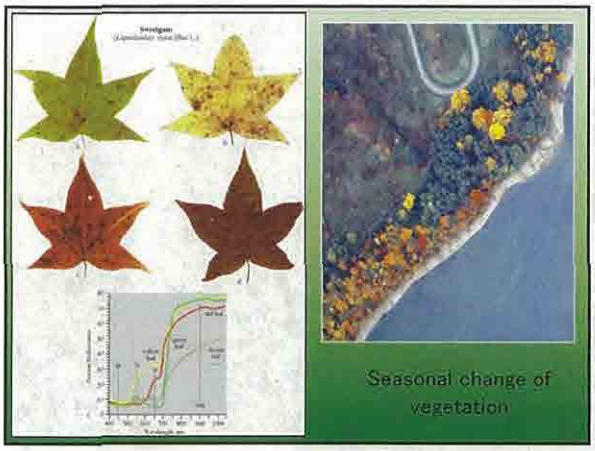
In situ spectroradiometer measurement of soybeans

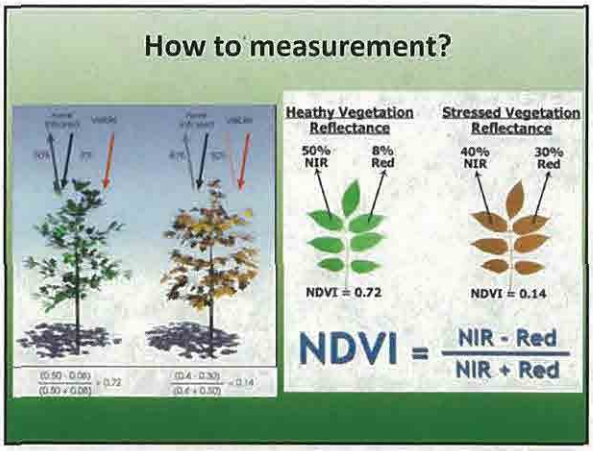
Spectral Reflectance Measurement using a Spectroradiometer

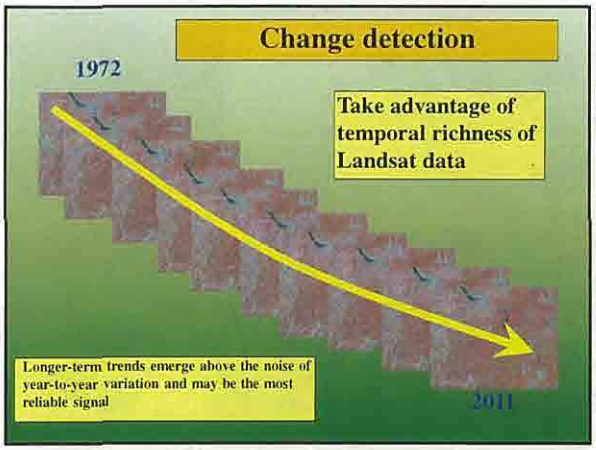
Reflectance from a leaf

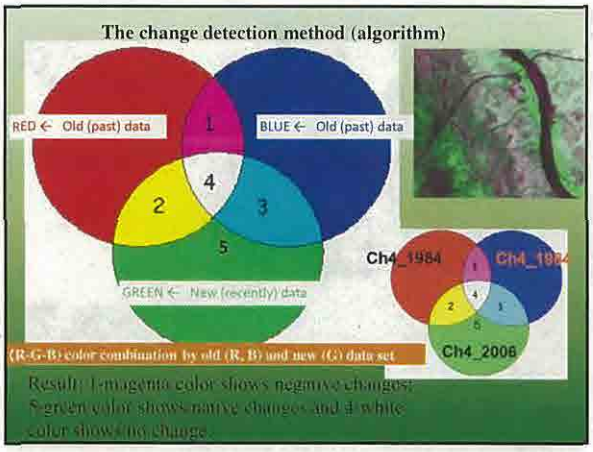


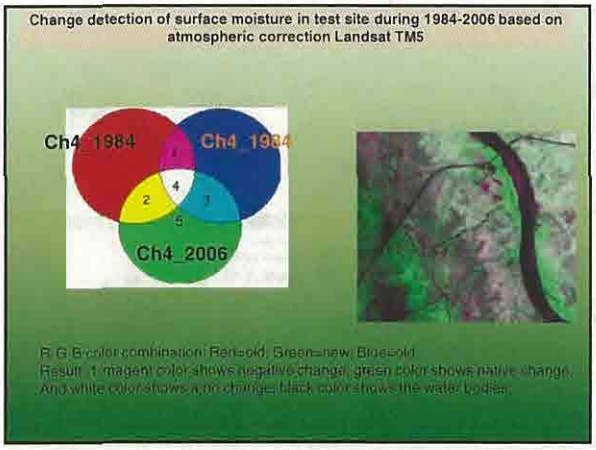
From Avery & Berlin, 1972

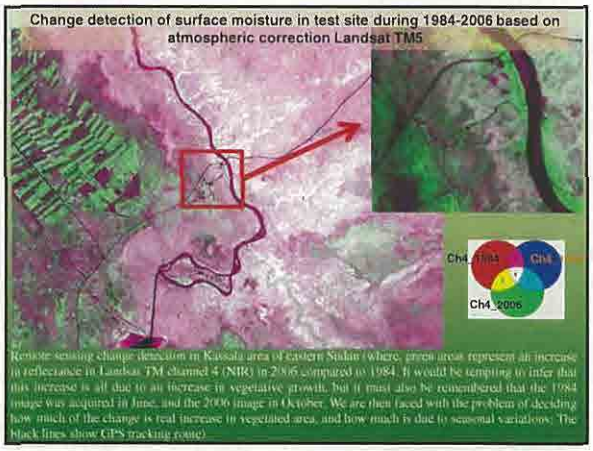

Seasonal change of vegetation

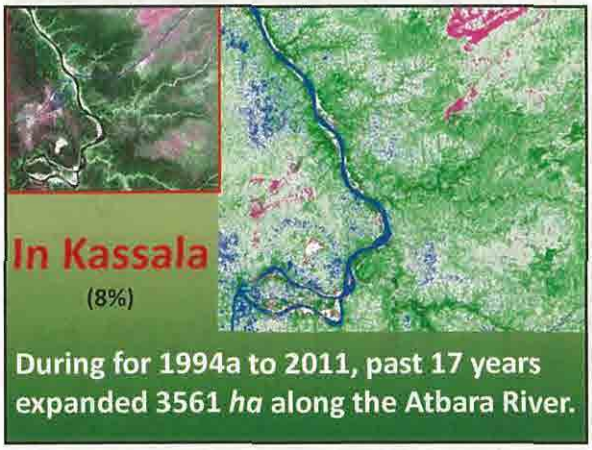

How to measurement?
Heathy Vegetation Reflectance
50% NIR
8% Red
NDVI = 0.72
Stressed Vegetation Reflectance
40% NIR
30% Red
NDVI = 0.14
NDVI = NIR - Red / NIR + Red


Change detection
1972
Take advantage of temporal richness of Landsat data
Longer-term trends emerge above the noise of year-to-year variation and may be the most reliable signal
2011


The change detection method (algorithm)
RED ← Old (past) data
BLUE ← Old (past) data
GREEN ← New (recently) data
(R-G-B) color combination by old (R, B) and new (G) data set
Ch4_1984
Ch4_2006
Result: 1-magenta color shows negative changes; 5-green color shows native changes and 4 white color showing change.


Change detection of surface moisture in test site during 1984-2006 based on atmospheric correction Landsat TM5
Ch4_1984
Ch4_2006
R-G-B color combination: Red=old, Green=new, Blue=old
Result: 1 magent color shows negative change, green color shows native change, And white color shows a no change, black color shows the water bodies.

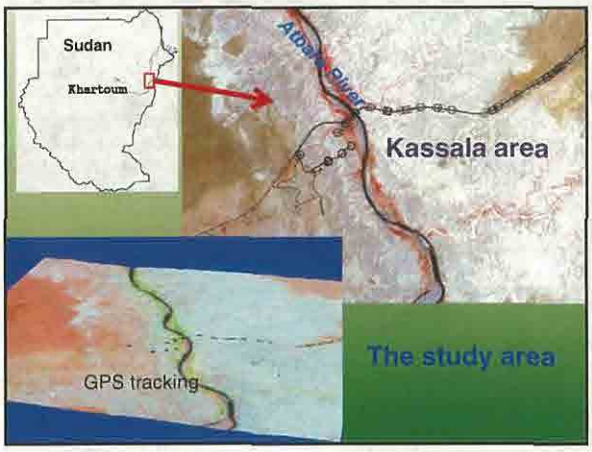

Change detection of surface moisture in test site during 1984-2006 based on atmospheric correction Landsat TM5
Ch4_2006
Remote sensing change detection in Kassala area of eastern Sudan (where, green areas represent an increase in reflectance in Landsat TM channel 4 (NIR) in 2006 compared to 1984. It would be tempting to infer that this increase is all due to an increase in vegetative growth, but it must also be remembered that the 1984 image was acquired in June, and the 2006 image in October. We are then faced with the problem of deciding how much of the change is real increase in vegetated area, and how much is due to seasonal variations. The black lines show GPS tracking zone)

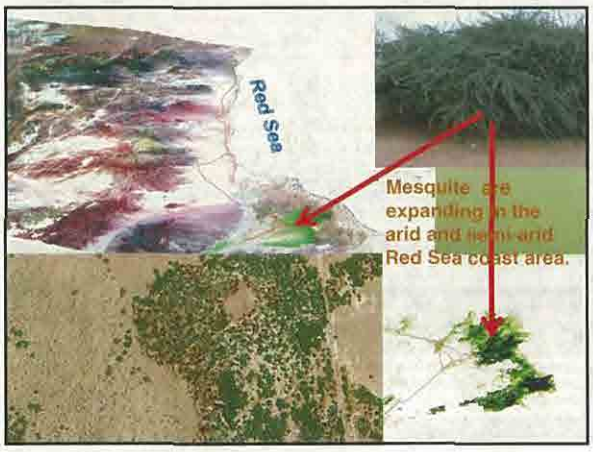


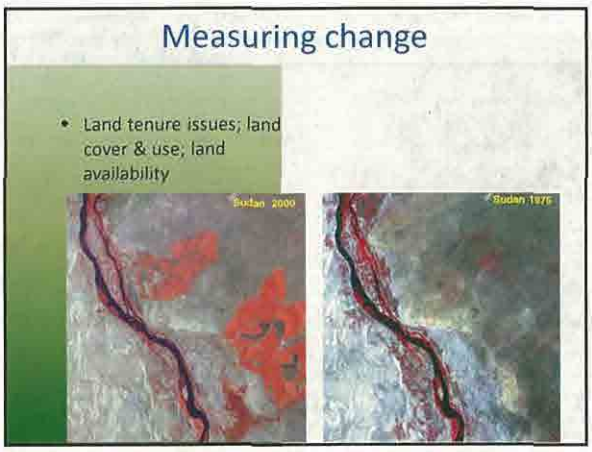
Final cluster class statistics

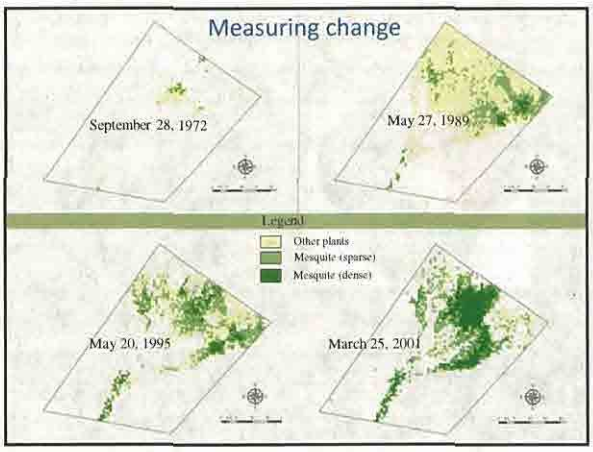
Cluster	Pixels	%	Area (Hectares)	Channel Means values 1994	2011	Δ NDVI
1	5,703	1.2	513.27	216.8	227	10.2
2	12,529	2.5	1127.61	76.4	239.5	163.1
3	14,098	2.8	1268.82	118.7	97.9	-20.8
4	27,038	5.5	2433.42	58.1	138.2	80.1
5	78,645	15.9	7078.05	66.1	86.4	20.3
6	76,064	15.4	6845.76	41.4	91.7	50.3
7	68,017	13.7	6121.53	42.7	59	16.3
8	93,266	18.8	8393.94	23.4	61.8	38.4
9	90,595	18.3	8153.55	15.7	38.7	23
10	29,045	5.9	2614.05	4.2	10.1	5.9

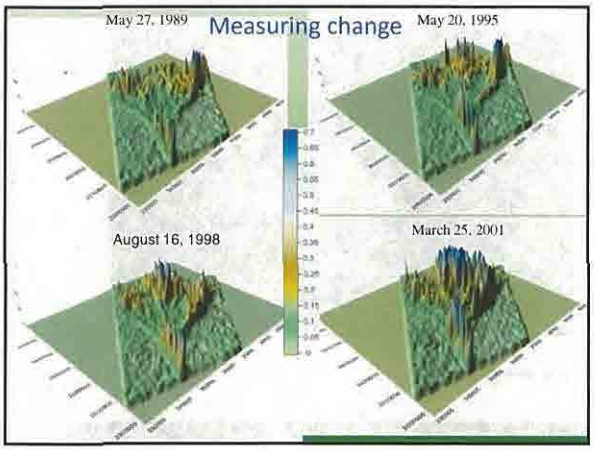
Cluster	Channel Standard Deviations (Std) 1	2	3
1	37.4	46.4	37.4
2	33.3	22.3	33.3
3	24.7	31.7	24.7
4	16.5	20.5	16.5
5	9.6	14.2	9.6
6	8.5	11.2	8.5
7	7.3	12.1	7.3
8	6.5	8.5	6.5
9	8	8.8	8
10	6.3	10.5	6.3

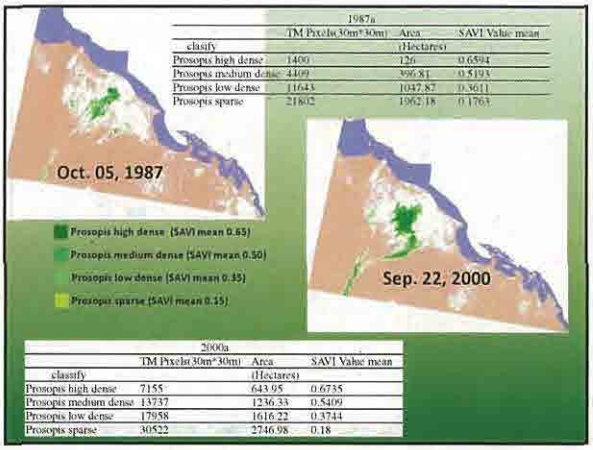










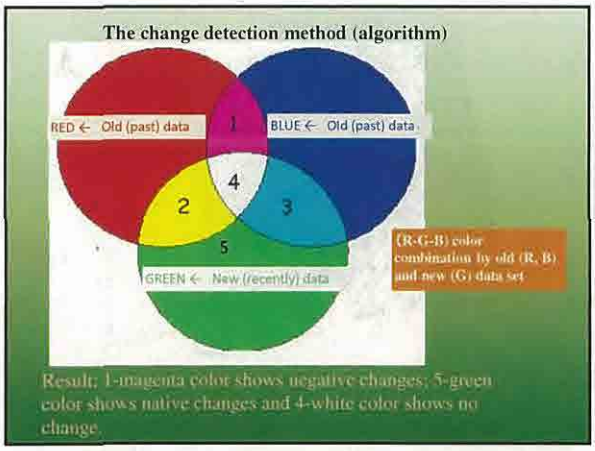


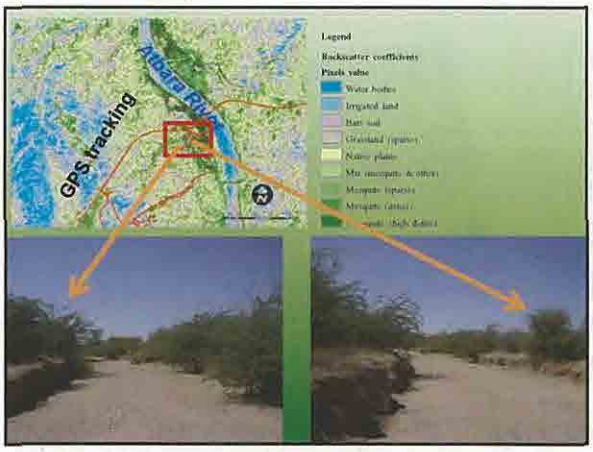
1987a

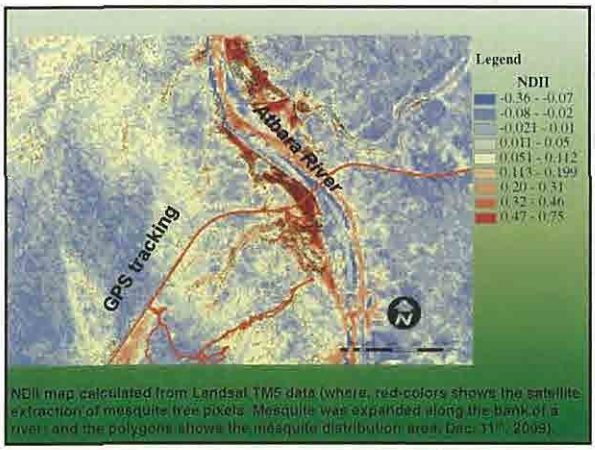
classify	TM Pixels(30m*30m)	Area (Hectares)	SAVI Value mean
Prosopis high dense	1400	126	0.6594
Prosopis medium dense	4409	396.81	0.5193
Prosopis low dense	11643	1047.87	0.3611
Prosopis sparse	21802	1962.18	0.1763

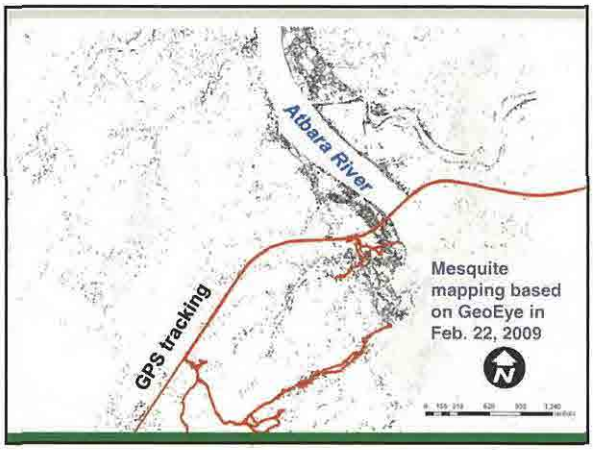
2000a

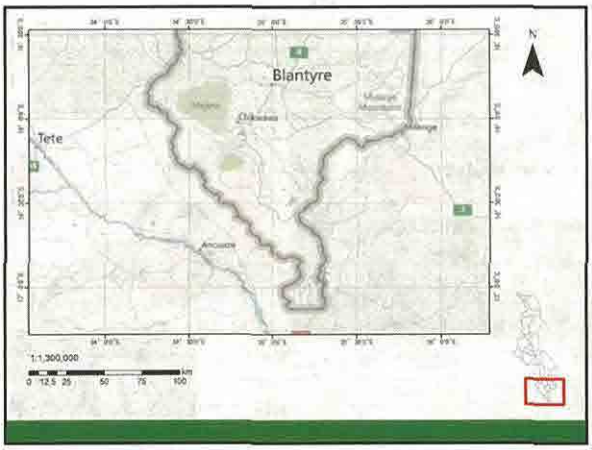
classify	TM Pixels(30m*30m)	Area (Hectares)	SAVI Value mean
Prosopis high dense	7155	643.95	0.6735
Prosopis medium dense	13737	1236.33	0.5409
Prosopis low dense	17958	1616.22	0.3744
Prosopis sparse	30522	2746.98	0.18

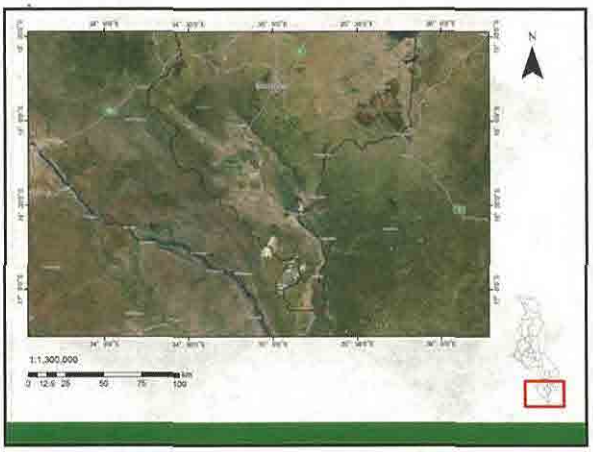


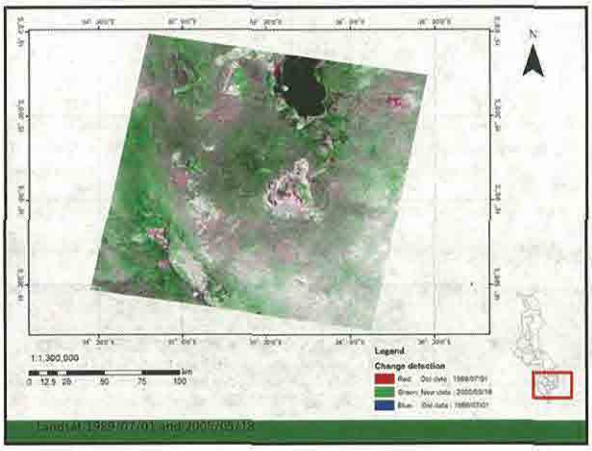


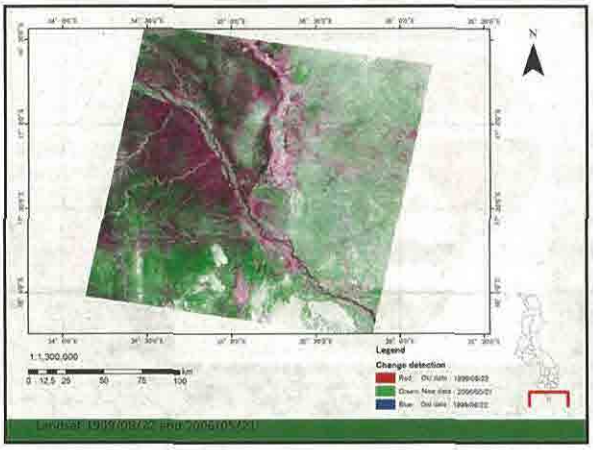


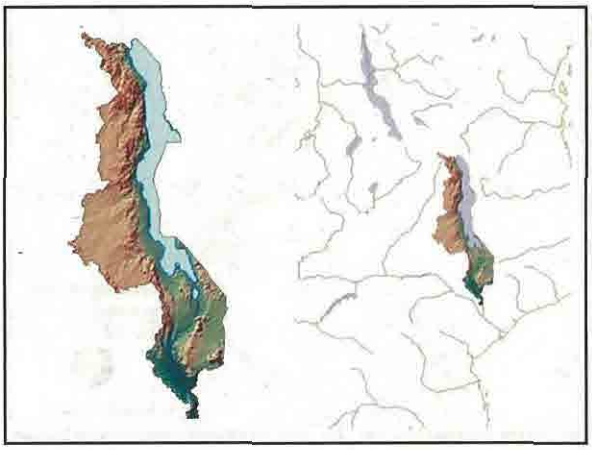


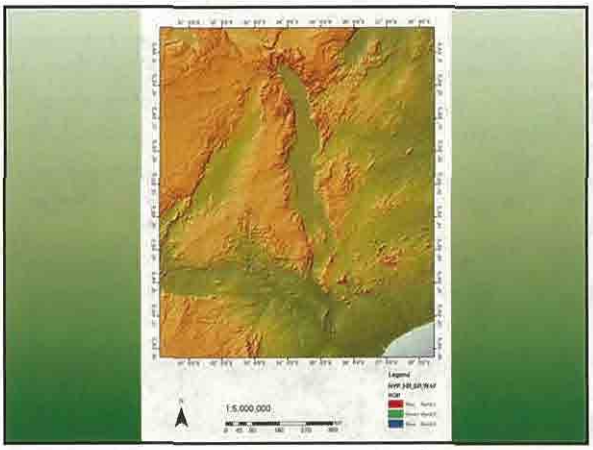

Blantyre
Tete
N
1:1,300,000
0 12.5 25 50 75 100 km

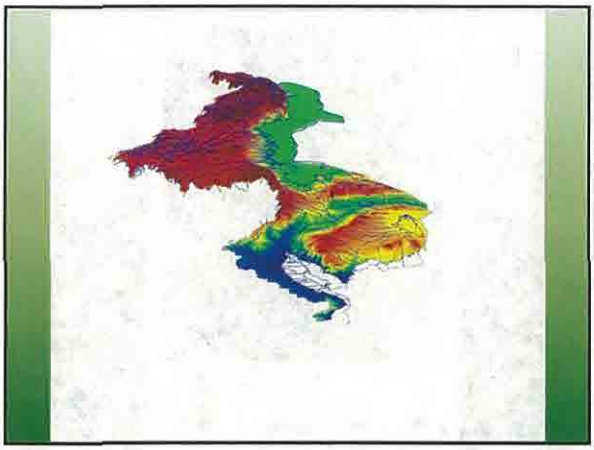

N
1:1,300,000
0 12.5 25 50 75 100 km

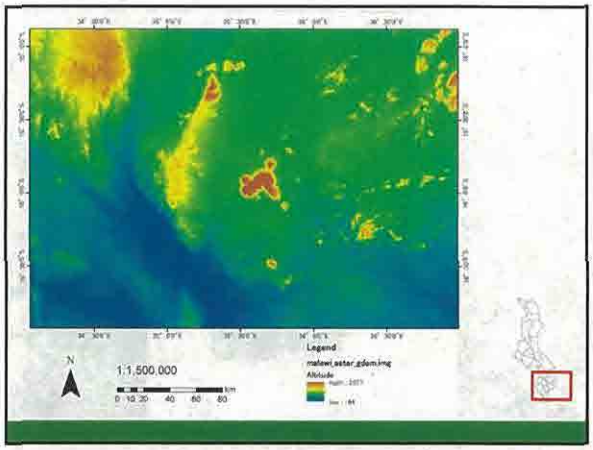

N
1:1,300,000
0 12.5 25 50 75 100 km
Legend
Change detection

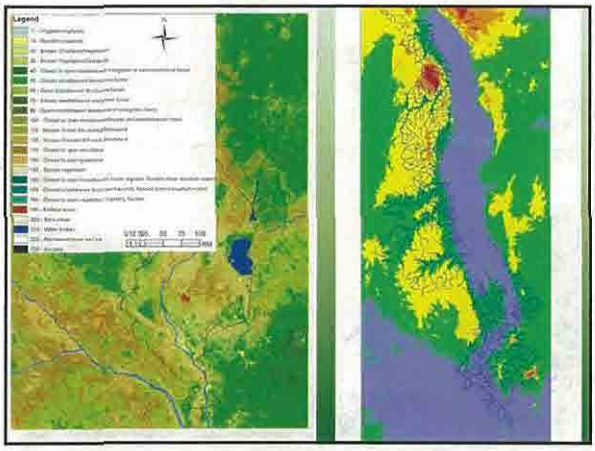

N
1:1,300,000
0 12.5 25 50 75 100 km
Legend
Change detection

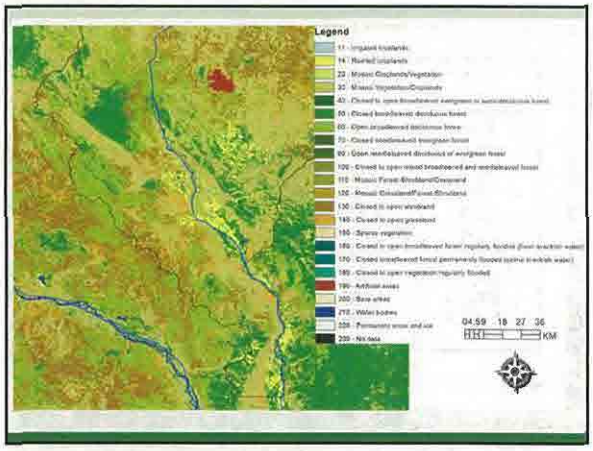


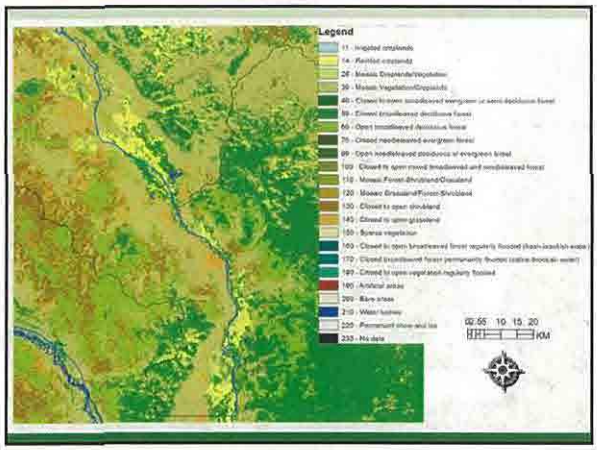

1:5,000,000

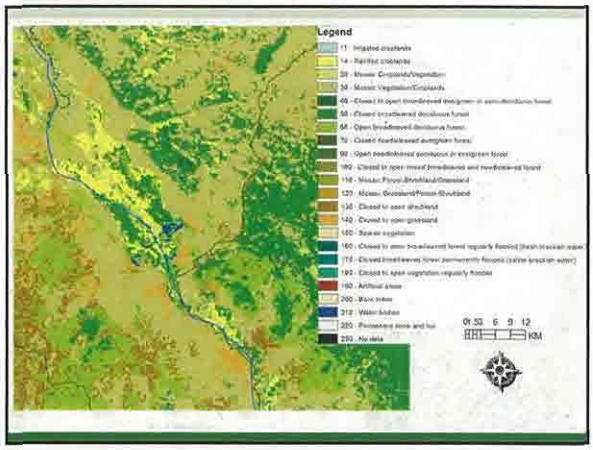


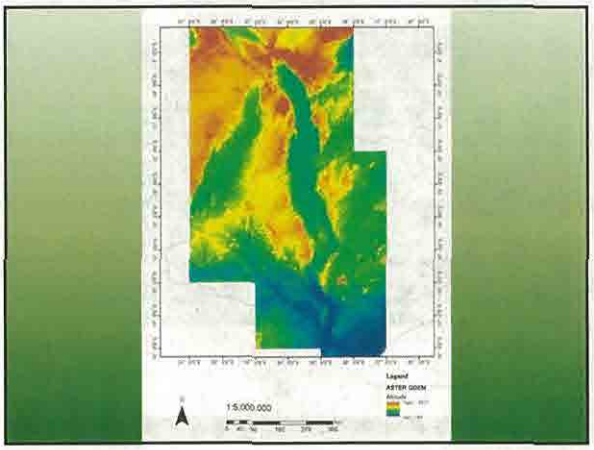

Legend
malawi_aster_gdem.img
Altitude
N
1:1,500,000
0 10 20 40 60 80
km

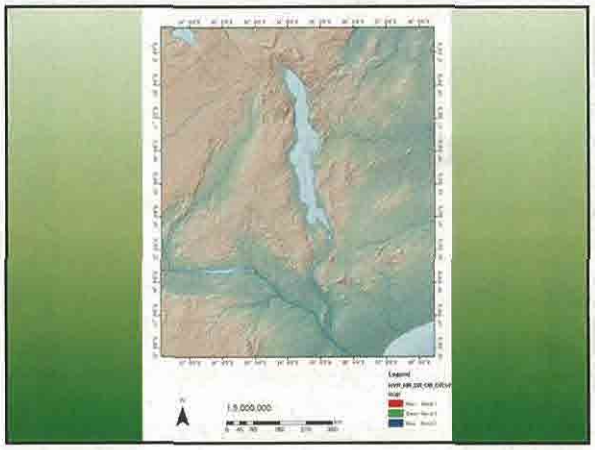

Legend


Legend
04.59 18 27 36
KM


Legend
02.55 10 15 20
KM

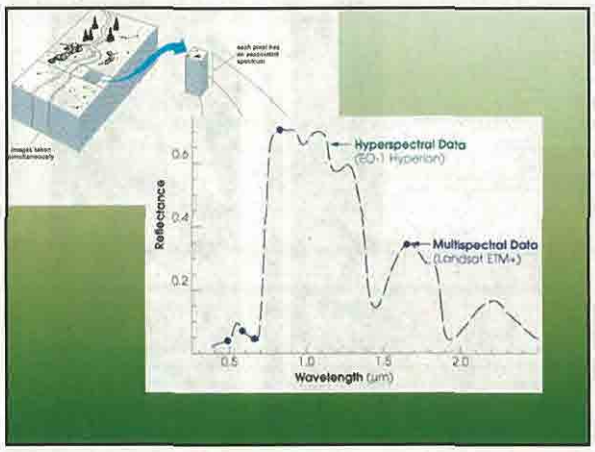

Legend
01.53 6 9 12
KM

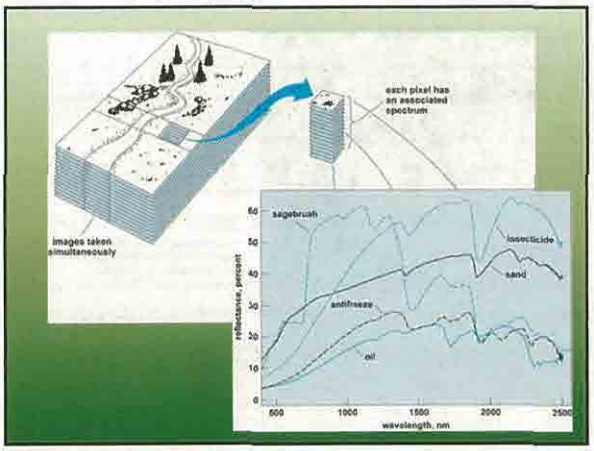


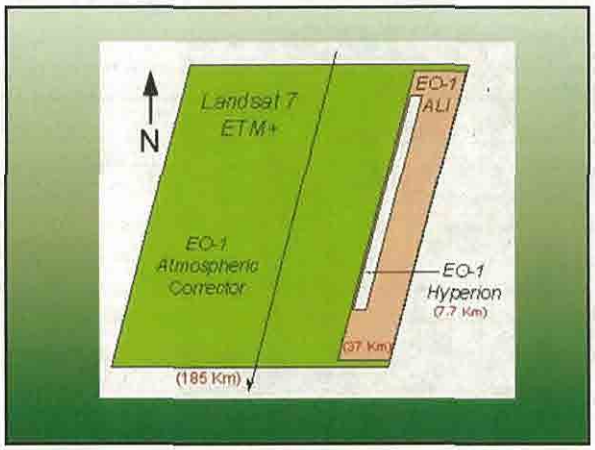


Band	Wavelength (μm)	Ground Sampling Distance (m)
Pan	0.48 – 0.69	10
MS-1'	0.433 – 0.453	30
MS-1	0.45 – 0.515	30
MS-2	0.525 – 0.605	30
MS-3	0.633 – 0.69	30
MS-4	0.775 – 0.805	30
MS-4'	0.845 – 0.89	30
MS-5'	1.2 – 1.3	30
MS-5	1.55 – 1.75	30
MS-7	2.08 – 2.35	30

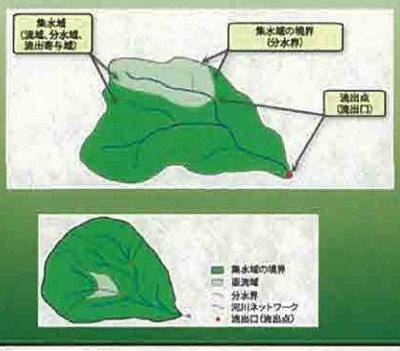
Table 1: Spectral and spatial definitions for the ten EO-1 ALI bands.

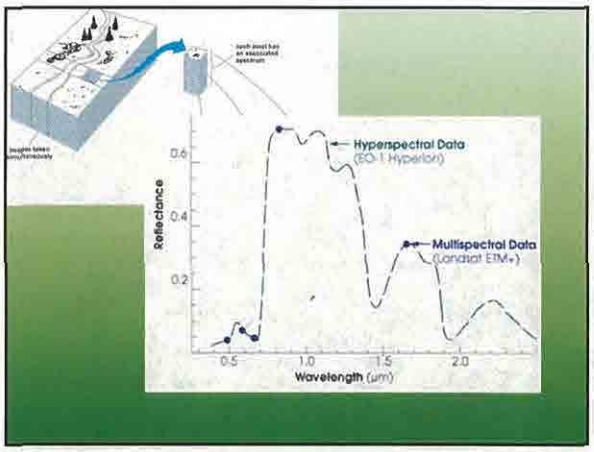


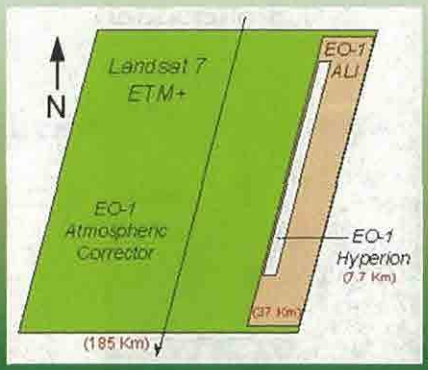




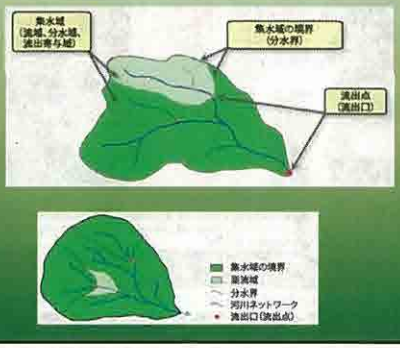
Watershed analysis using GIS and RS tools







Watershed analysis using GIS and RS tools



GIS Applications

- 1. Cartographic
  - Irrigation
  - Land evaluation
  - Crop Analysis
  - Air Quality
  - Traffic patterns
  - Planning and facilities management
- 2. Digital Terrain Modeling
  - Earth science resources
  - Civil Engineering & Military Evaluation
  - Soil Surveys
  - Pollution Studies
  - Flood Control
- 3. Geographic objects
  - Car navigation systems
  - Utility distribution and consumption
  - Consumer product and services

GIS Data Format

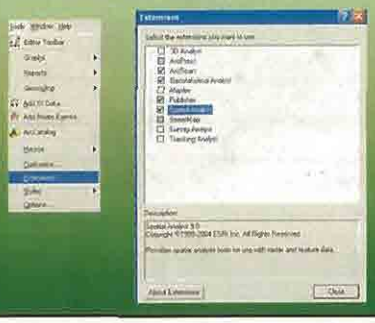
- Modeling
  1. Vector – geometric objects such as points, lines and polygons
  2. Raster – array of points
- Analysis
  1. *Geomorphometric –slope values, gradients, aspects,* convexity
  2. Aggregation and expansion
  3. Querying
- Integration
  1. Relationship and conversion among vector and raster data

Watershed analysis using ArcGIS

1. Digital Elevation Model (DEM)
2. Flow direction
3. Flow accumulation
4. Identify and removing sink
5. Stream Network
6. Stream Links
7. Watershed analysis

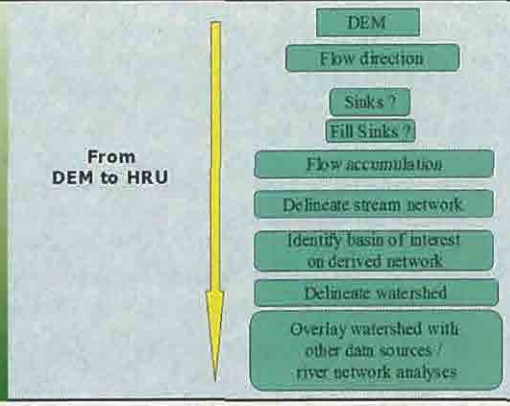
How to turn on Hydrologic Modeling

1. First turn on Spatial Analyst

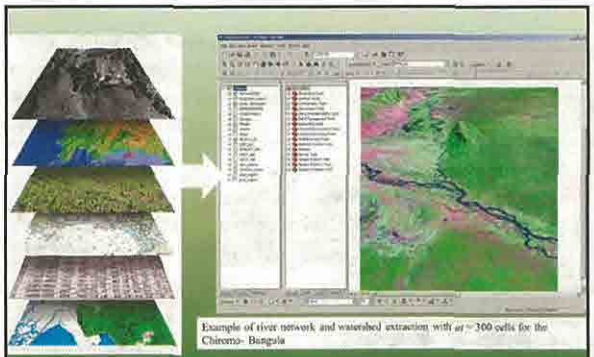


Hydrology Tools

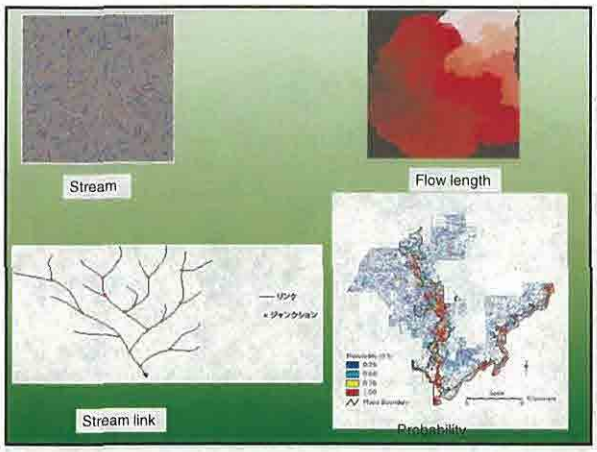
- Activate ArcToolbox from window menu
- Expand "Hydrology" from "Spatial Analyst" Tools

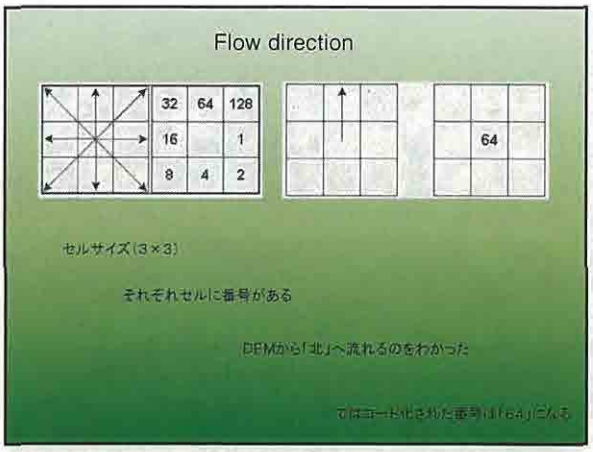


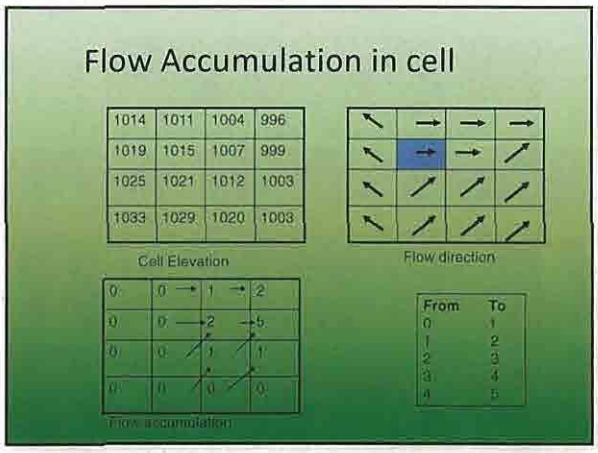
Basic procedure for the definition of river networks and watershed boundaries.

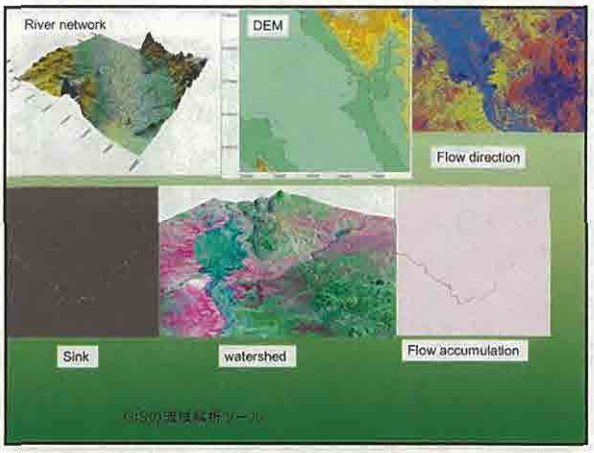


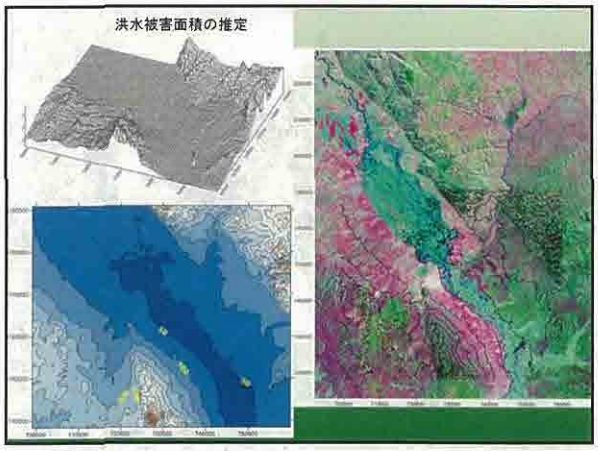
The main menu toolbar and the "layers", "toolbox" and "view" windows.

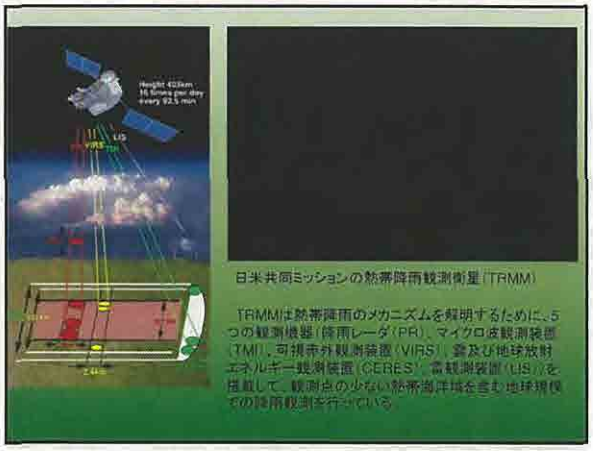

Stream
Flow length
Stream link
Probability

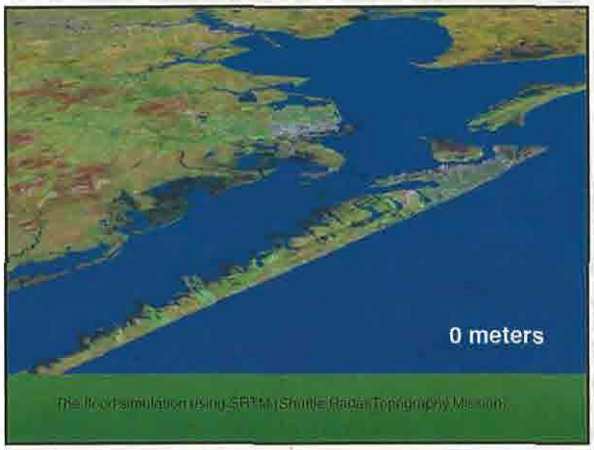

Flow direction
32 64 128
16 1
8 4 2
64
セルサイズ(3×3)
それぞれセルに番号がある
DEMから「北」へ流れるのをわかった
ではコードに出された番号は「64」になる

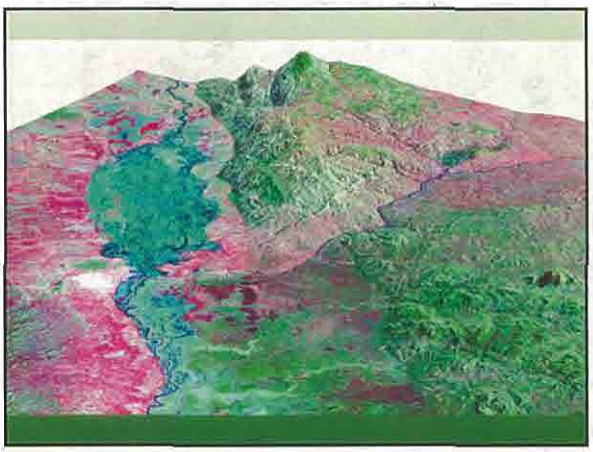

Flow Accumulation in cell
1014 1011 1004 996
1019 1015 1007 999
1025 1021 1012 1003
1033 1029 1020 1003
Cell Elevation
Flow direction
Flow accumulation
From To
0 1
1 2
2 3
3 4
4 5

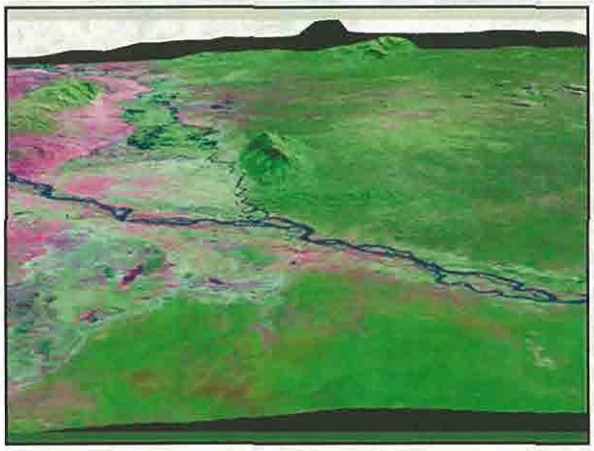

River network
DEM
Flow direction
Sink
watershed
Flow accumulation

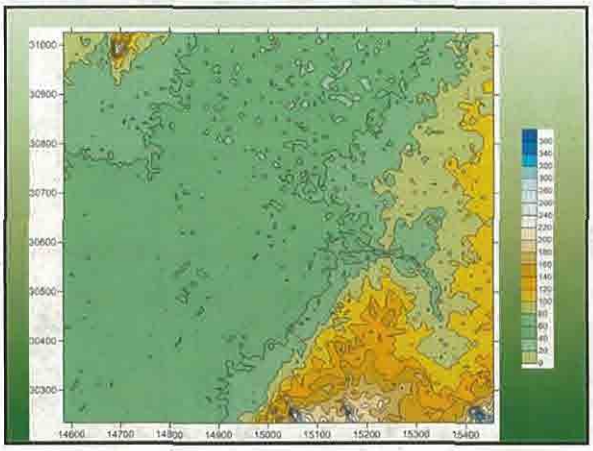

洪水被害面積の推定


日米共同ミッションの熱帯降雨観測衛星（TRMM）
TRMMは熱帯降雨のメカニズムを解明するために、5つの観測機器（降雨レーダ（PR）、マイクロ波観測装置（TMI）、可視赤外観測装置（VIRS）、雲及び地球放射エネルギー観測装置（CERES）、雷観測装置（LIS））を搭載して、観測点の少ない熱帯海洋域を含む地球規模での降雨観測を行っている。


0 meters
The flood simulation using SRTM (Shuttle Radar Topography Mission)



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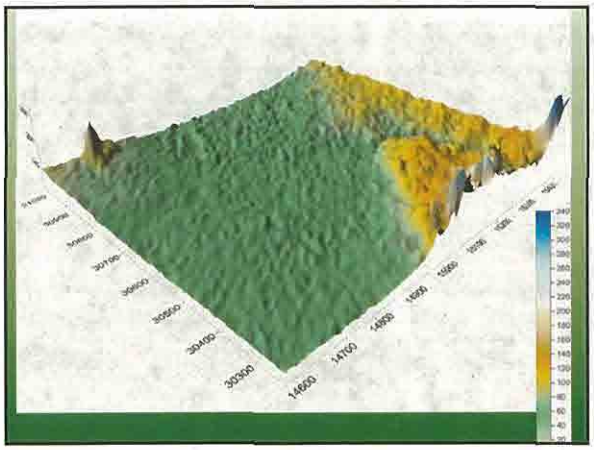
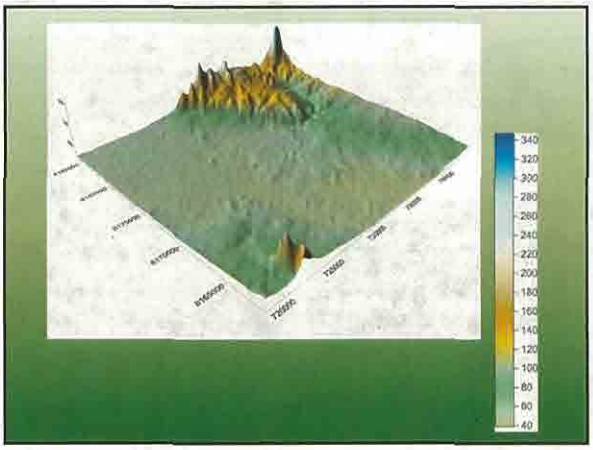
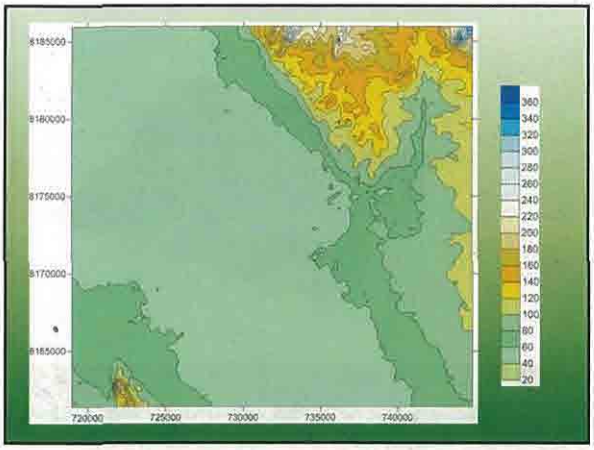
30900
30800
30700
30600
30500
30400
30300
14600
14700
14800
14900
15000
15100
15200
15300
15400



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6180000
6175000
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6165000
720000
725000
730000
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740000
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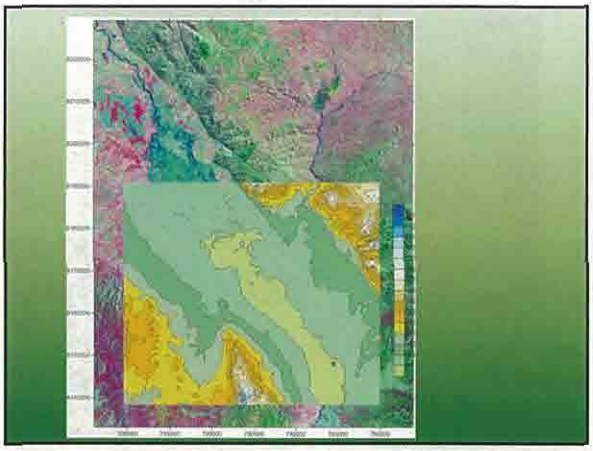
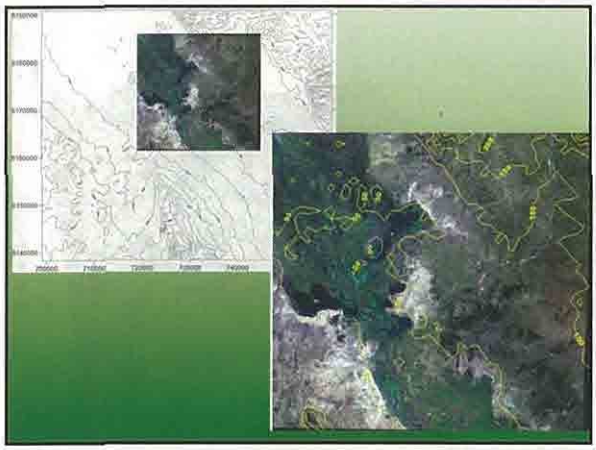
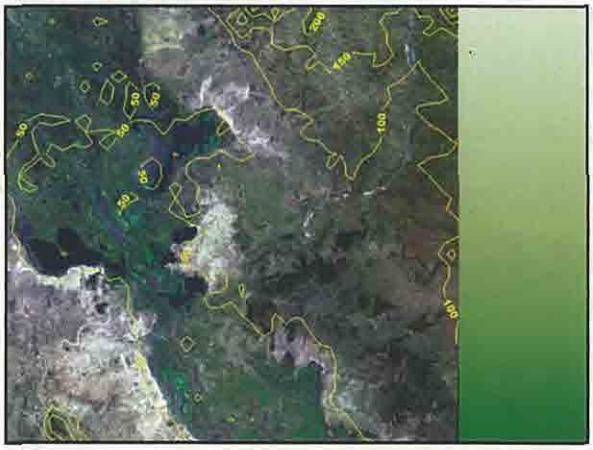
40
20



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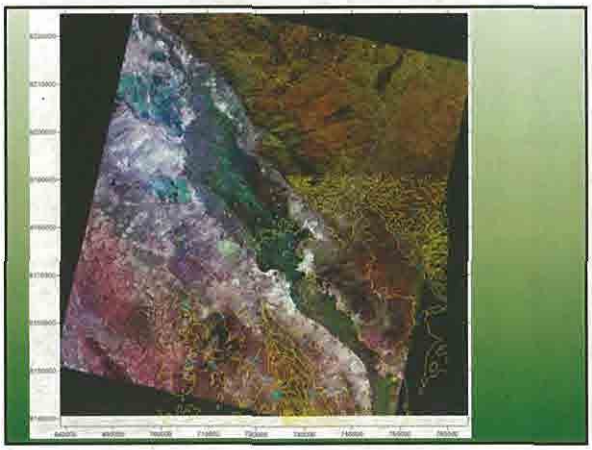
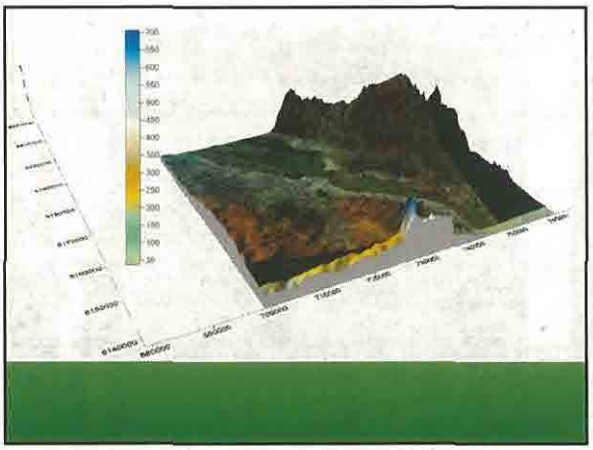
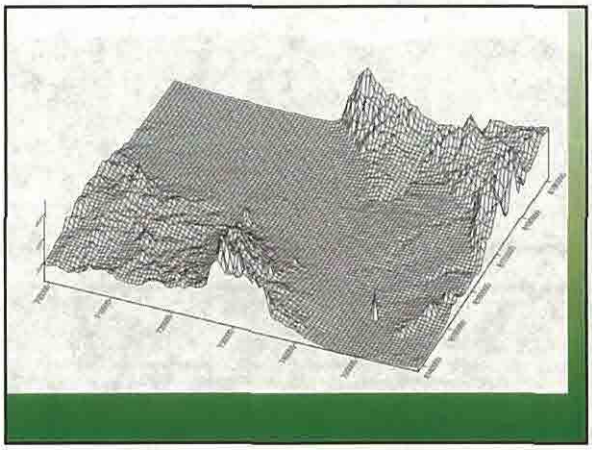
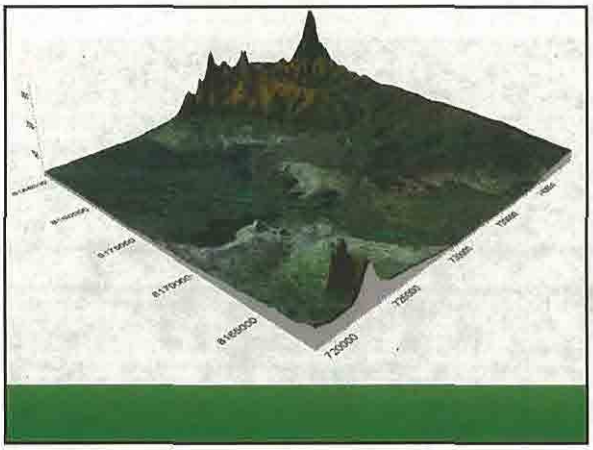
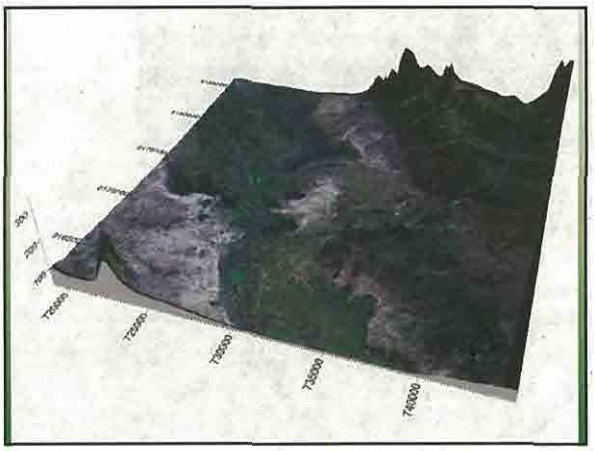
150
100
50
100

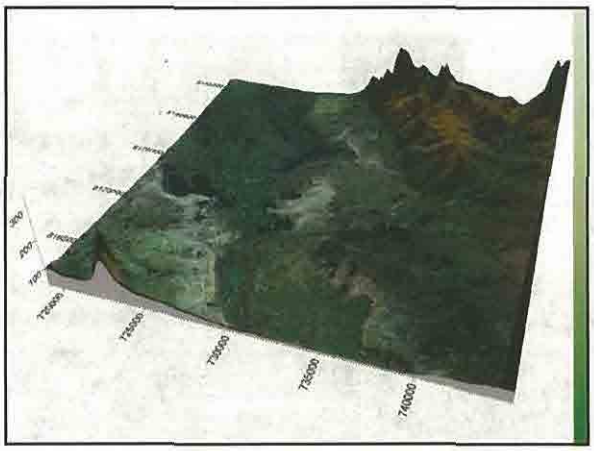


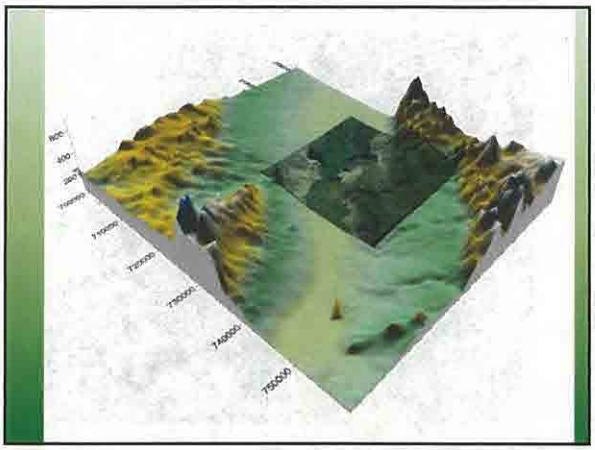








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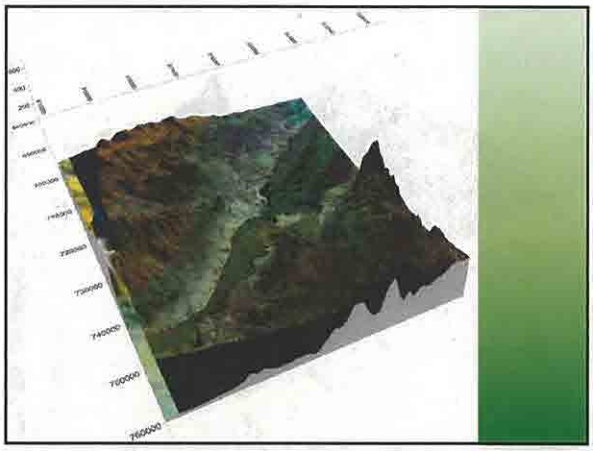
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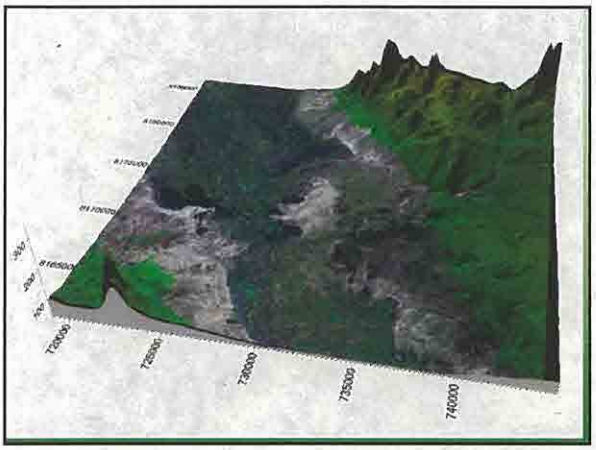
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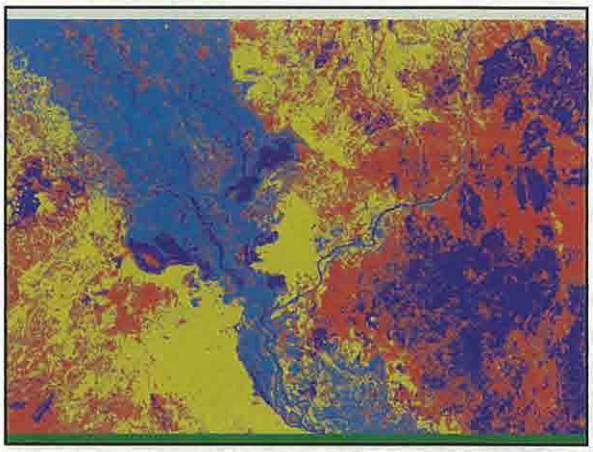
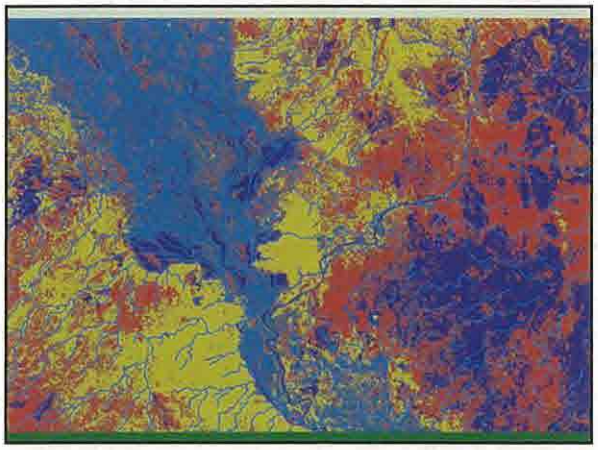
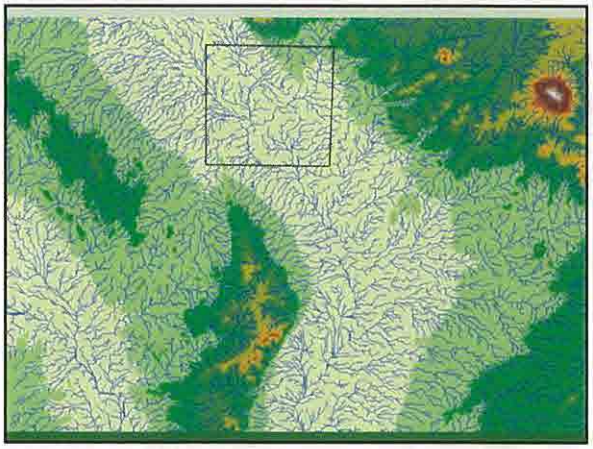
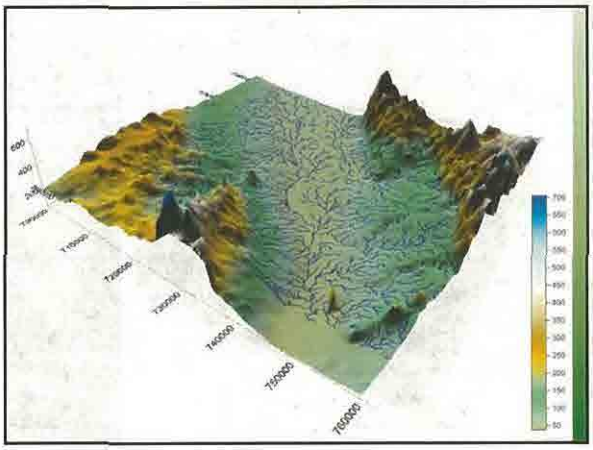
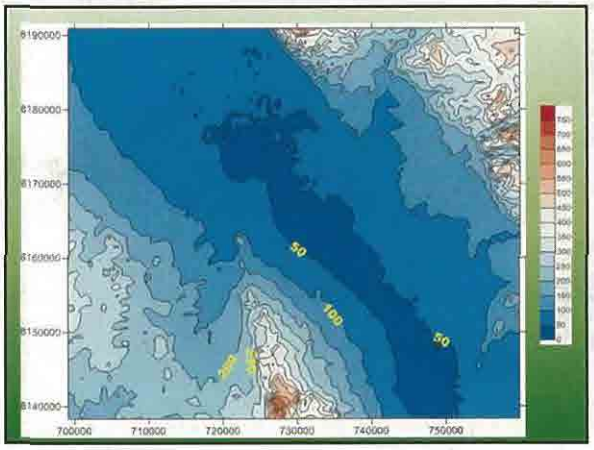
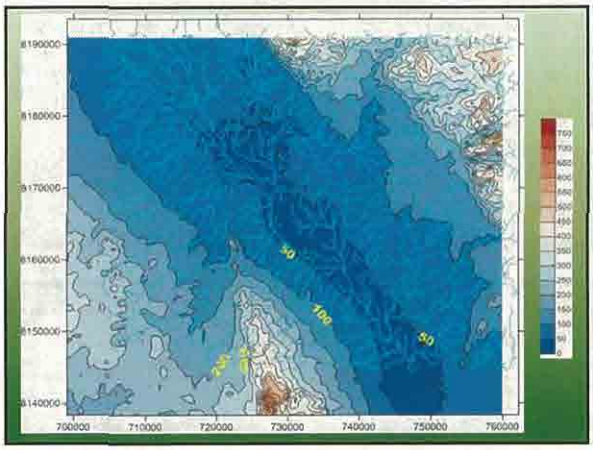


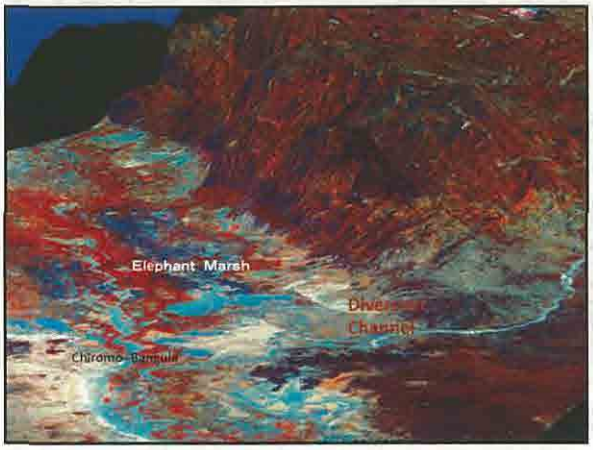












We can do!

Free Data: GLCF
Earth explorer

Free remote sensing software: MultiSpec

Free GIS software: QGIS
DIVA-GIS

Biodiversity

Biodiversity refers to diversity of

1. Species
2. Habitats
3. Genetic Diversity (within a species)

- Scientists estimate that upwards of 10 million—and some suggest more than 100 million—different species inhabit the Earth. Each is uniquely adapted to a particular habitat.
- Scientists have discovered and named only 1.75 million species—less than 20 percent of those estimated to exist.

Terra/MODIS Three Cover Index

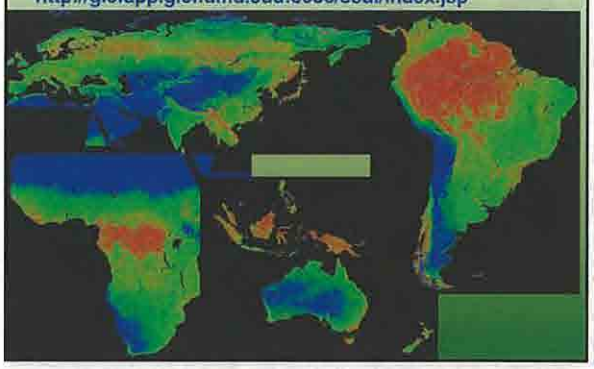
MODIS, Vegetation Continuous Fields

The three data files included are percent trees, bare, and herbaceous. This product contains three available layers which add up to represent 100% ground cover. The three layers can be properly displayed in a Red, Green, Blue band combolation. Data is available in Goode's projection or Lat/Long.

http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp

MODIS, Vegetation Continuous Fields

http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp



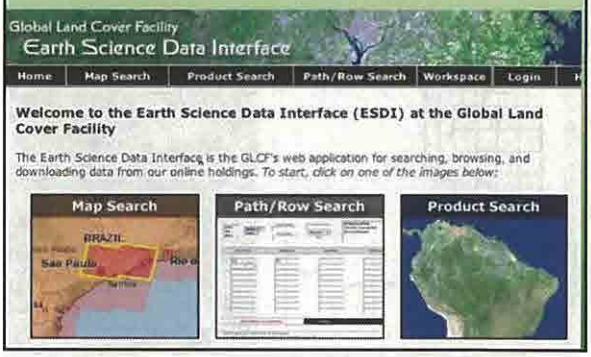
Landsat GeoCover

Global Land Cover Facility

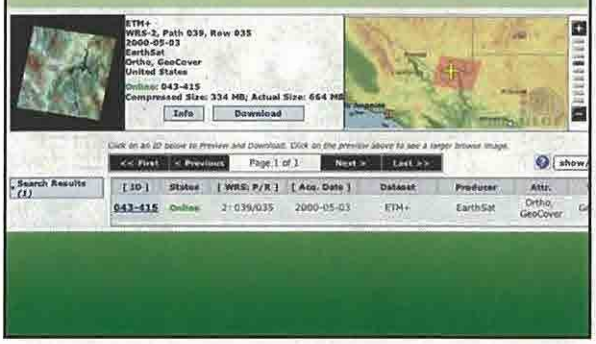
- Free GeoCover Landsat data can be downloaded from Global Land Cover Facility Web site.
- GeoCover is high resolution as opposed to other global data sets
- GeoCover is available in the standard GeoTIFF format

Source: GLCF Presentations

ESDI Map Search for Data: 1



ESDI Map Search for Data: 2



Getting Landsat Data

Ortho, GeoCover

Landsat 7, ETM+

Czech Republic, Germany, Poland

2000-06-20

MultiSpec Software

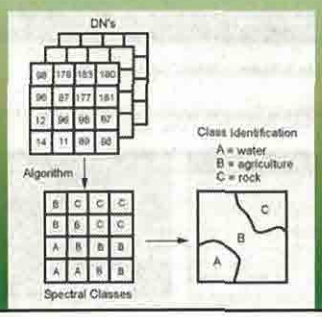
What is MultiSpec?

- MultiSpec is a free software from Purdue University for Macintosh and PC computers.
- MultiSpec allows digital manipulation of Landsat images
  - Zoom in/out
  - Examine different band combinations
  - Examine spectral properties of pixels/groups of pixels
  - Perform "blue-band correction" on images
- MultiSpec is used to produce a computer assisted land cover map and study change detection

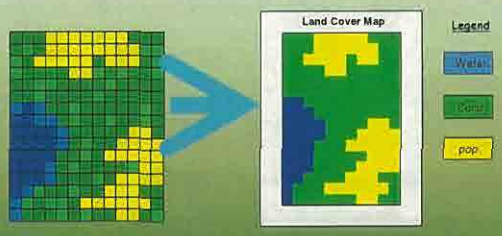
Unsupervised classification

- Analyst has minimal interaction
- Computer algorithm searches for natural, inherent groupings in remote sensing images
- Clustering algorithm – ISODATA
- *Analyst determines categories for these* spectral groups by comparing classified image to ground reference data

Unsupervised classification



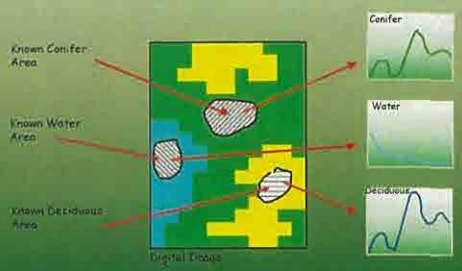
Source: Canadian Centre for Remote Sensing



Supervised Classification

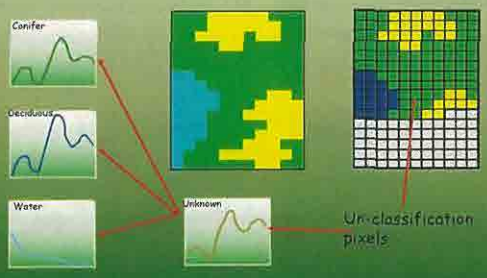
Make training area

Spectral characteristics



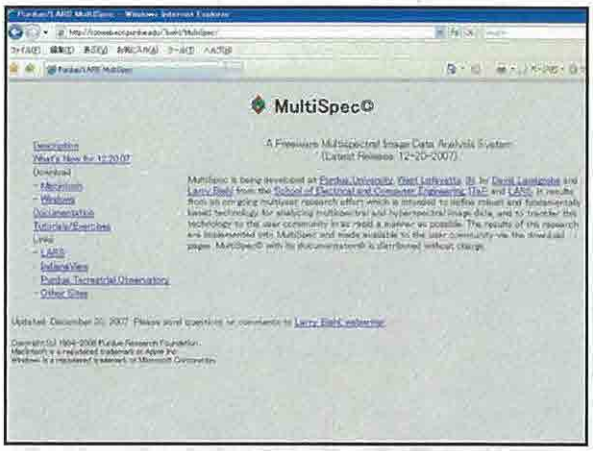
Supervised Classification

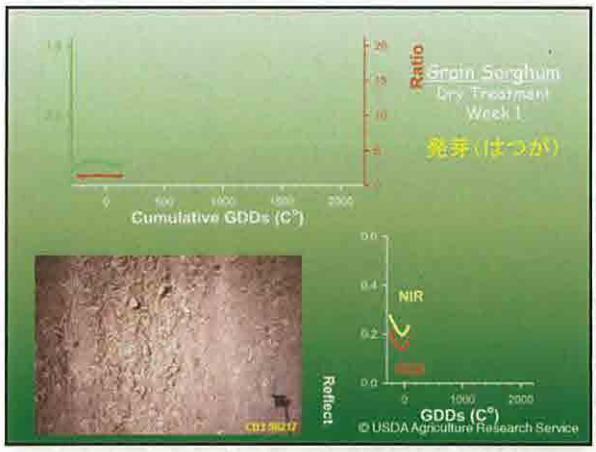
GIS Information

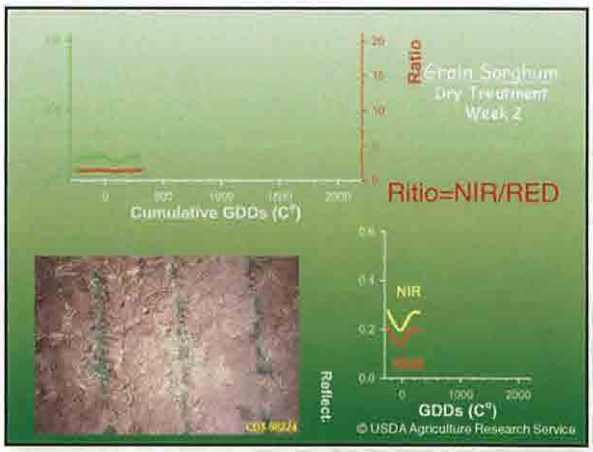


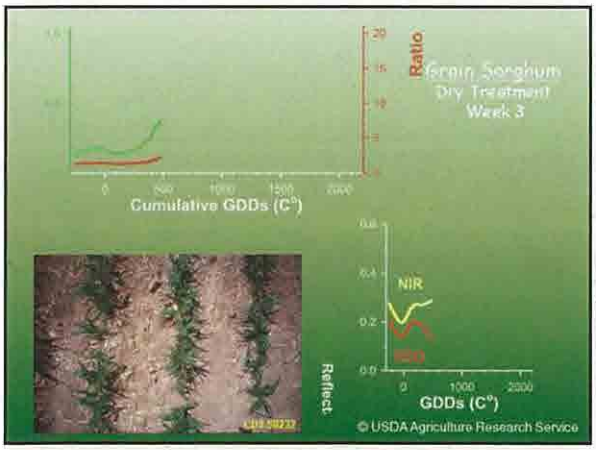
Multispec

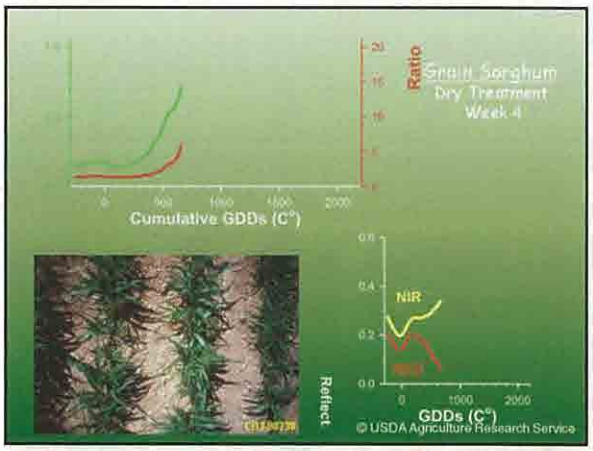
- **Developed at Purdue University – free!**
- Works on 512 by 512 images
- Simple image processing techniques
- Techniques today – Delaware, OH area
  - Image display
  - Image classification
- Take home images of your school area
- http://www.ece.purdue.edu/~biehl/MultiSpec/

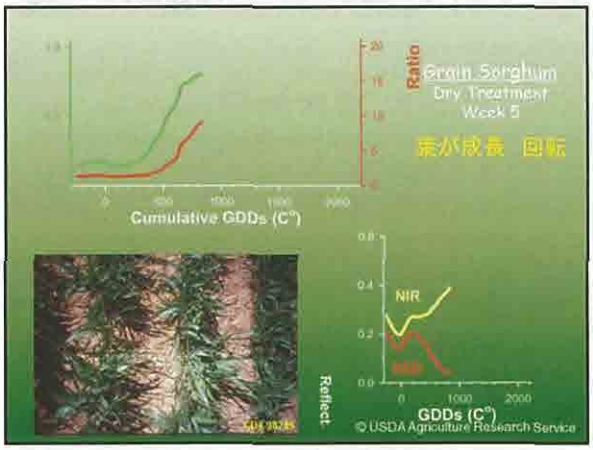


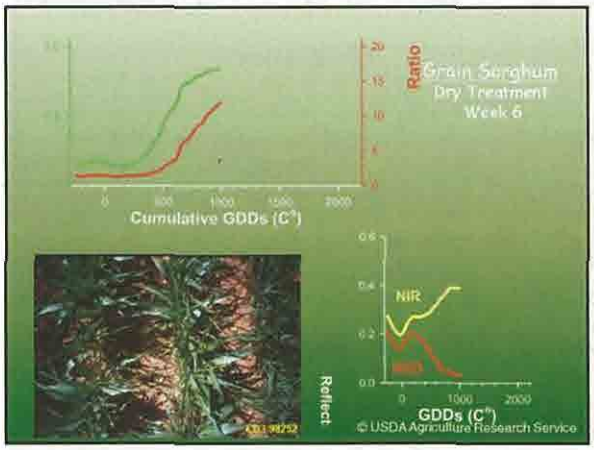


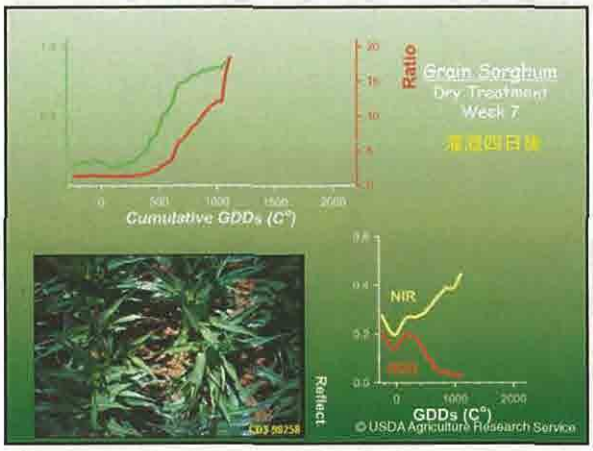


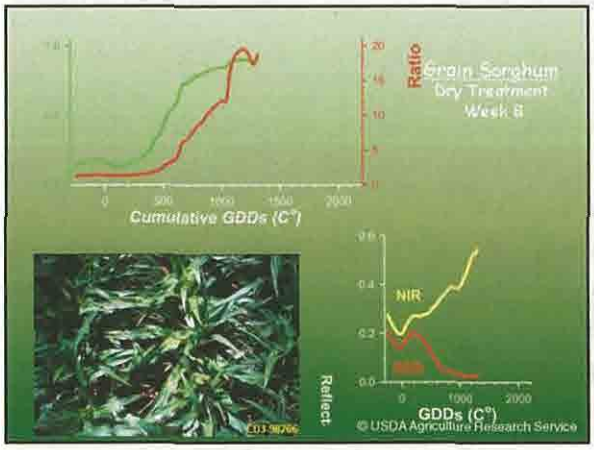


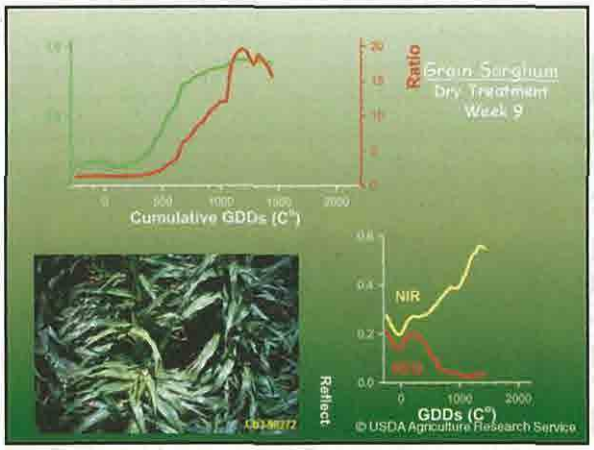


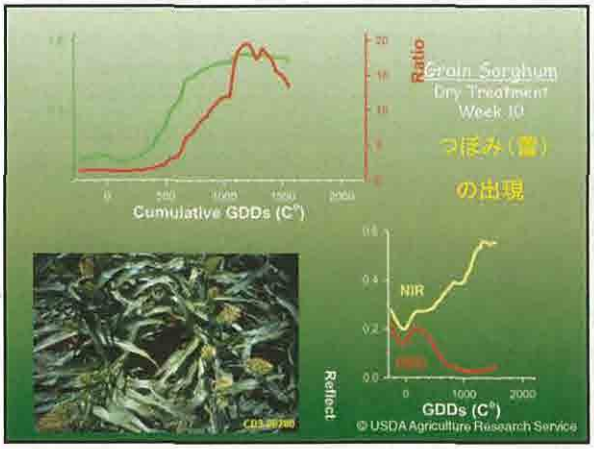

Grain Sorghum
Dry Treatment
Week 5
茎が成長　回転
Ratio
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service

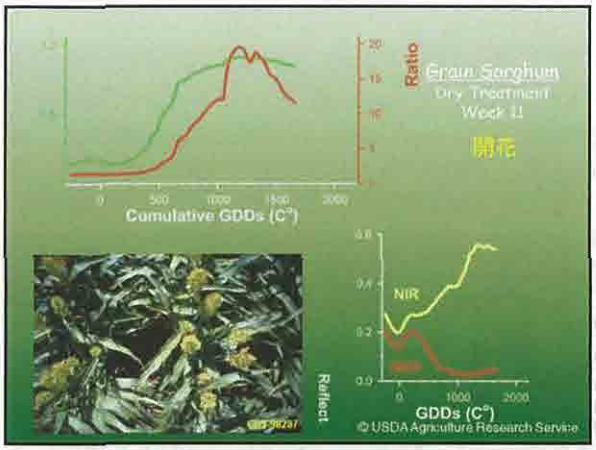

Grain Sorghum
Dry Treatment
Week 6
Ratio
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service

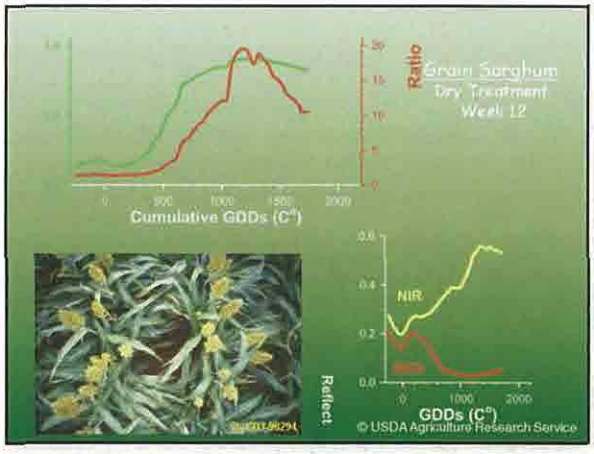

Grain Sorghum
Dry Treatment
Week 7
灌漑四日後
Ratio
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service

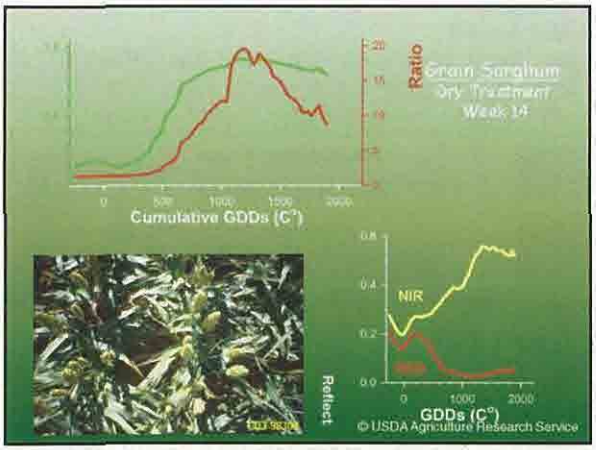

Grain Sorghum
Dry Treatment
Week 8
Ratio
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Grain Sorghum
Dry Treatment
Week 9
Ratio
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Grain Sorghum
Dry Treatment
Week 10
つぼみ（穂）
の出現
Ratio
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Ratio
Grain Sorghum
Dry Treatment
Week 11
開花
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Ratio
Grain Sorghum
Dry Treatment
Week 12
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Ratio
Grain Sorghum
Dry Treatment
Week 14
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
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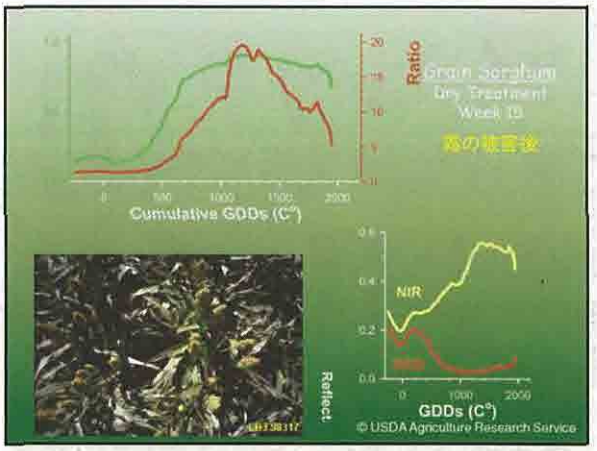
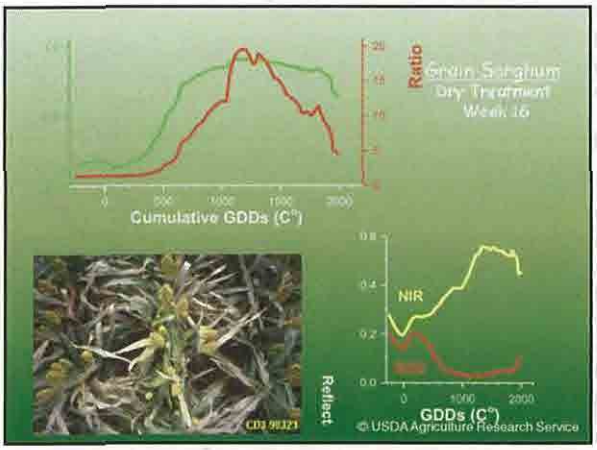
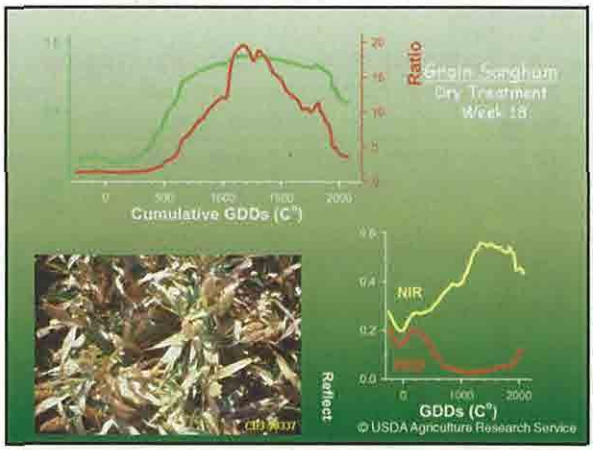
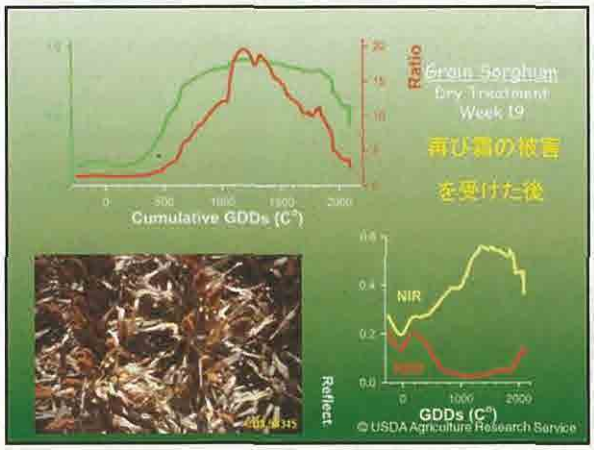
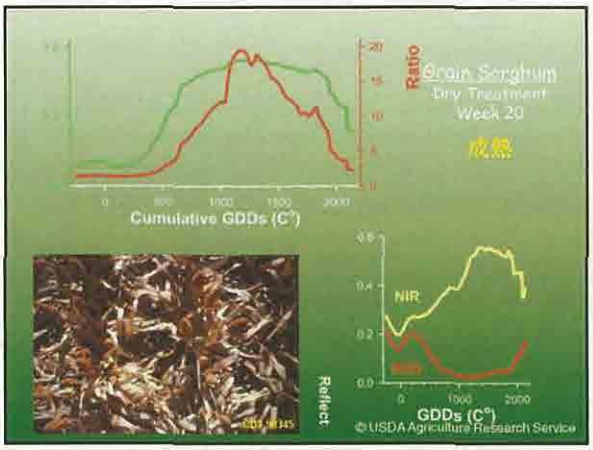
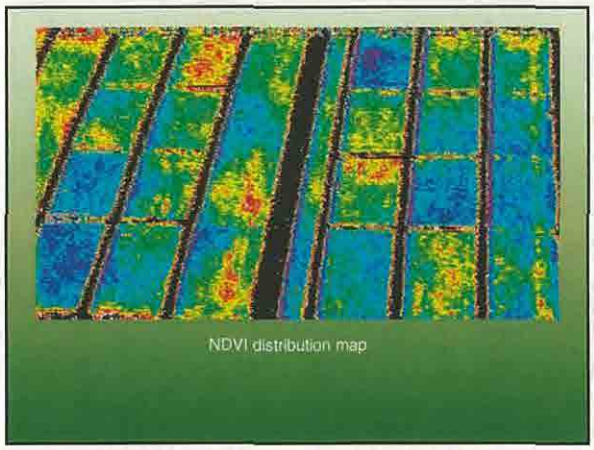

Ratio
Grain Sorghum
Dry Treatment
Week 15
穂の被覆後
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Ratio
Grain Sorghum
Dry Treatment
Week 16
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service


Ratio
Grain Sorghum
Dry Treatment
Week 18
Cumulative GDDs (C°)
NIR
Reflect
GDDs (C°)
© USDA Agriculture Research Service



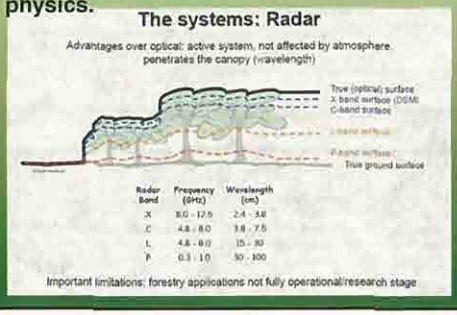




NDVI distribution map

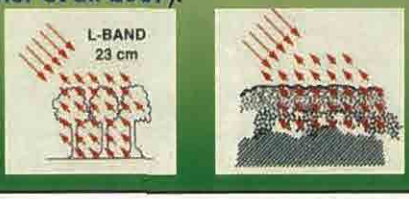
INTRODUCTION

Microwave remote sensing is the most effective technique for soil moisture estimation, with advantages for all-weather observations and solid physics.



INTRODUCTION

Low frequency microwave measurements are known to be beneficial for soil moisture retrieval due to their capability to better penetrate vegetation (top) and the high sensitivity to the dielectric constant of the wet soil (second from top) (Wagner et al. 2007).



Methodology

The total backscatter σ^0_{dB} from a vegetated soil surface consists of three types of contributions: backscatter from bare soil surface (σ^0_s), direct backscatter of the vegetation layer (σ^0_{dv}), and multiple backscattering (σ^0_{int}), involving the vegetation canopy and ground surfaces is given by:

$$\sigma^0_{dB} = \tau^2\sigma^0_s + \sigma^0_{dv} + \sigma^0_{\text{int}}$$

total | soil | canopy | both

The polarimetric backscattering with a good accuracy for bare-soil surfaces. It is well known that the retrieval of soil moisture in vegetated surface from the microwave backscatter coefficient is affected by surface roughness.

Methodology

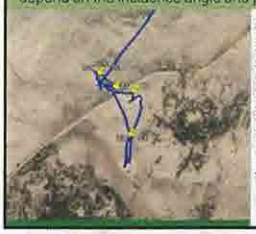
$$\sigma^0_{dB} = \tau^2 \sigma^0_s + \sigma^0_c + \sigma^0_{sc}$$

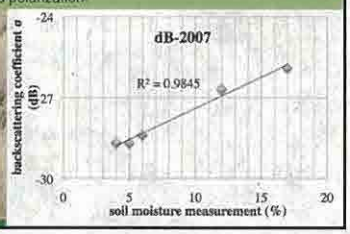
total | soil | canopy | both

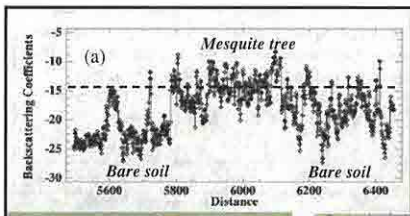
Soil moisture estimation retrieved backscattering coefficients are based for numerous studies on a simple linear relationship between the mean signal and volumetric soil moisture (*VSM*), written as:

$$VSM = a \times \sigma^0 + b$$

In the equation, *VSM* is volumetric soil moisture (%), *a* and *b* are coefficients that depend on the incidence angle and polarization.







Active microwave can provide high spatial resolution but has low revisit frequency and is more sensitive to soil roughness and vegetation.

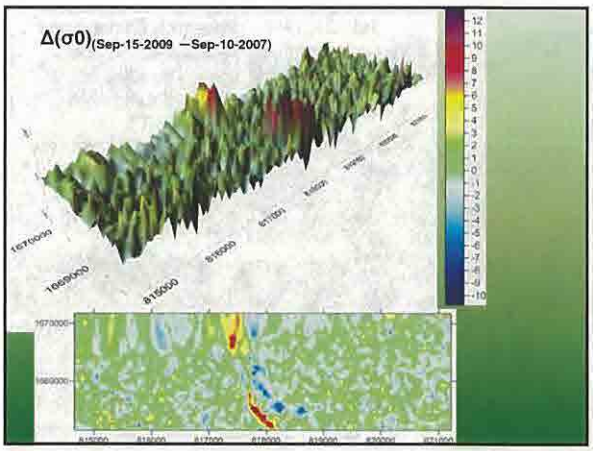
Methodology

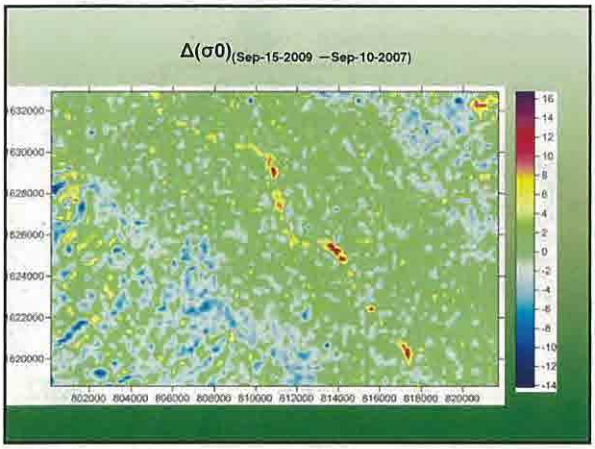
To reduce the effect of roughness on a retrieval of soil moisture, a ratio of backscatter coefficient for wet and dry soil has been calculated. The backscatter coefficient **subtraction** values (September 10th, 2007 and September 15th, 2009) are shows that changes in the soil moisture in the bare soil area were greater than that in mesquite tree ground.

It has been suggested that during two years period (from 2007 to 2009) the mesquite trees are grown up little, because the value of $\Delta\sigma^0$ was small positive (0 to + 4) in the mesquite tree area. Contrary, the soil moisture of bare soil in the Albara River basin showed a great change ($\Delta\sigma^0$ was ($+4 < \Delta\sigma^0$) and ($0 > \Delta\sigma^0$).

$$\sigma^t_{dB} = \tau^2 \sigma^t_s + \sigma^t_{dv} + \sigma^t_{int}$$

$$\Delta VSM = f^{-1}(R, m, \varepsilon) = \Delta\sigma^0_{dB} = (\sigma^{t_2}_{dB} - \sigma^{t_1}_{dB}) = \Delta\sigma^0_{dB}$$





A NEW METHOD FOR ESTIMATION OF SOIL MOISTURE FROM PALSAR POLARIZATION DATA IN HIGH DENSITY VEGETATED AREA

Buho Hoshino [*1], G. Kudo [2], Y. Amagai [2], M. Kaneko [1], T. Yabuki [1]

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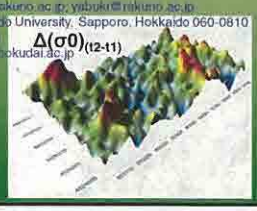
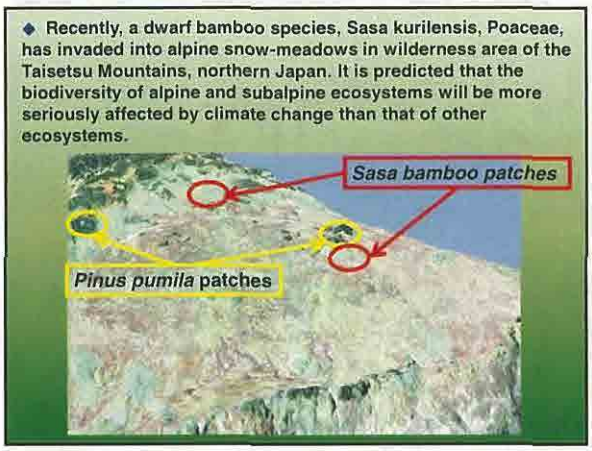
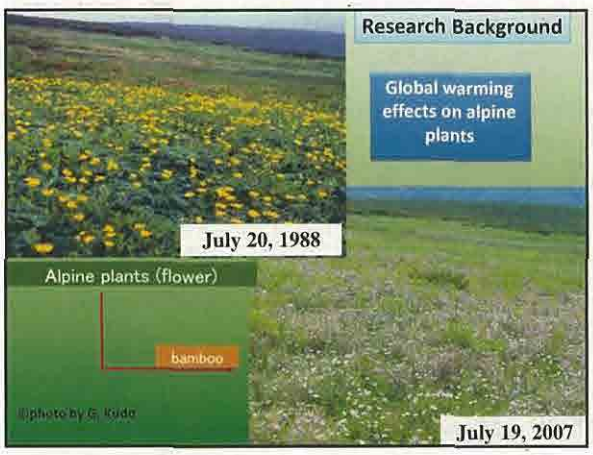
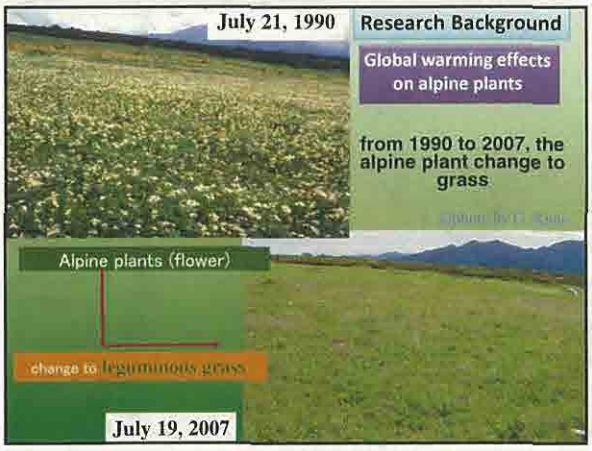
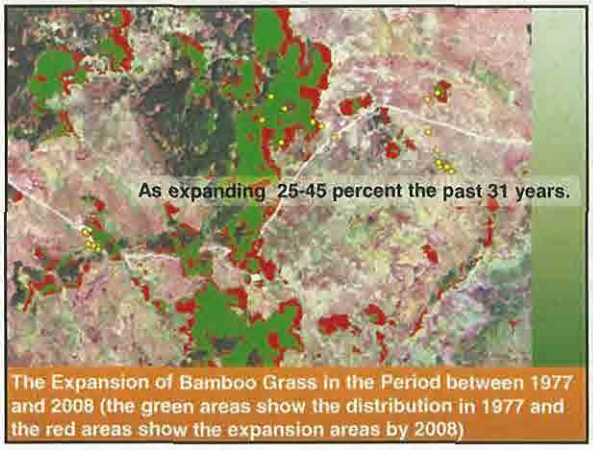
Email: ecsier@rakuno.ac.jp, kaneko@rakuno.ac.jp, yabuki@rakuno.ac.jp
[2]Faculty of Environmental Earth Science, Hokkaido University, Sapporo, Hokkaido 060-0810 Japan
Email: gaku@ees.hokudai.ac.jp

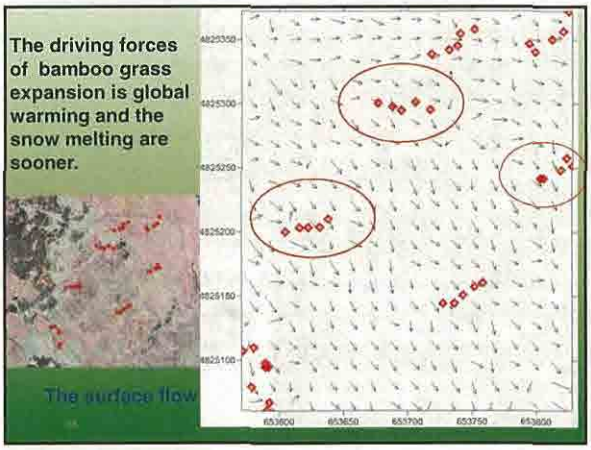


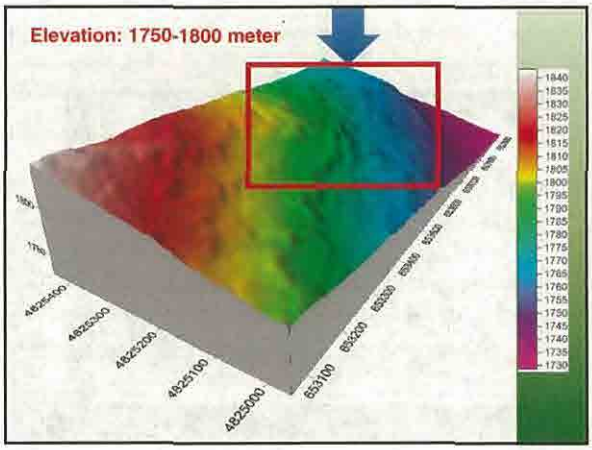

◆ Recently, a dwarf bamboo species, Sasa kurilensis, Poaceae, has invaded into alpine snow-meadows in wilderness area of the Taisetsu Mountains, northern Japan. It is predicted that the biodiversity of alpine and subalpine ecosystems will be more seriously affected by climate change than that of other ecosystems.
Sasa bamboo patches
Pinus pumila patches

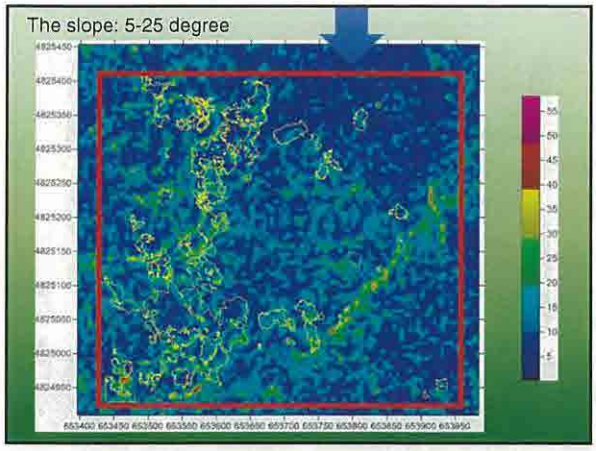

Research Background
Global warming effects on alpine plants
July 20, 1988
Alpine plants (flower)
bamboo
©photo by G. Kudo
July 19, 2007

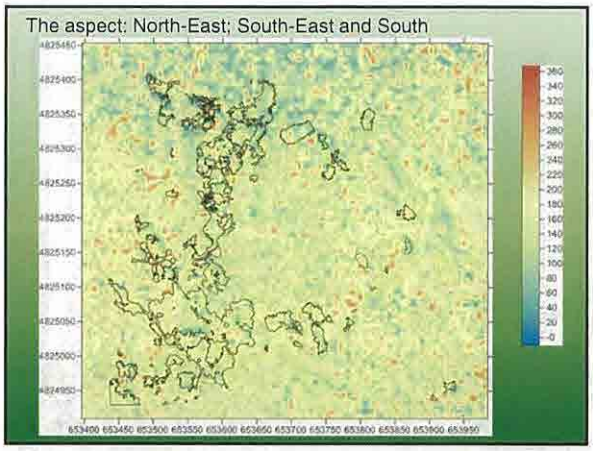

July 21, 1990
Research Background
Global warming effects on alpine plants
from 1990 to 2007, the alpine plant change to grass
Alpine plants (flower)
change to leguminous grass
July 19, 2007

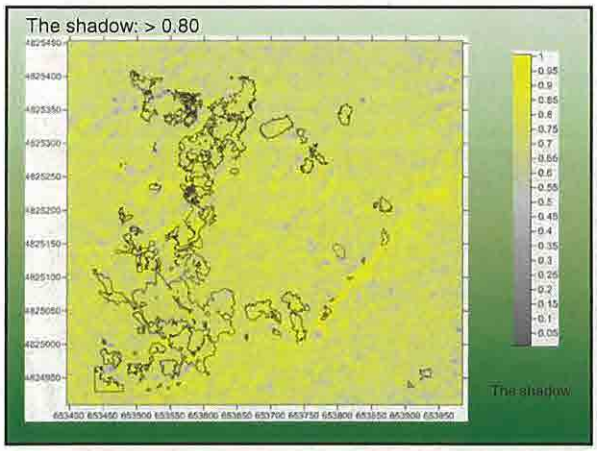

As expanding 25-45 percent the past 31 years.
The Expansion of Bamboo Grass in the Period between 1977 and 2008 (the green areas show the distribution in 1977 and the red areas show the expansion areas by 2008)

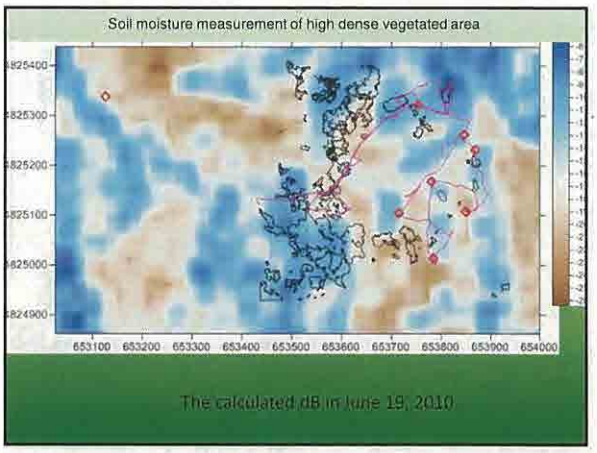

The driving forces of bamboo grass expansion is global warming and the snow melting are sooner.
The surface flow

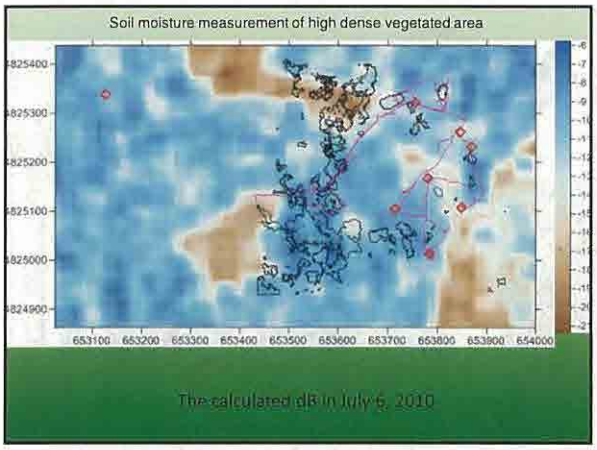

Elevation: 1750-1800 meter

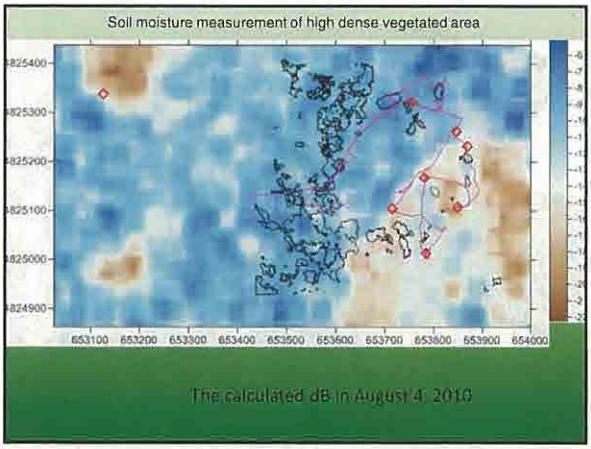

The slope: 5-25 degree

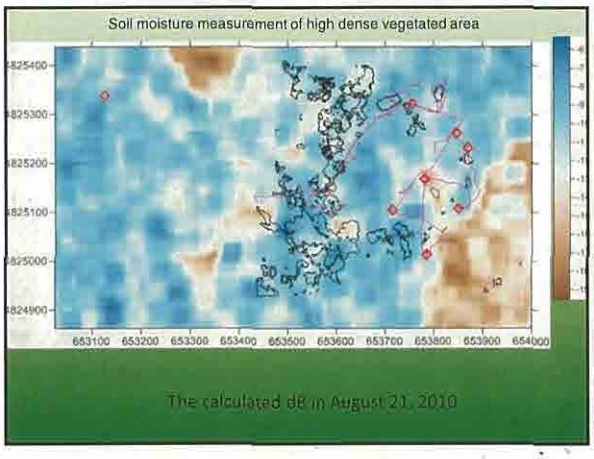

The aspect: North-East; South-East and South

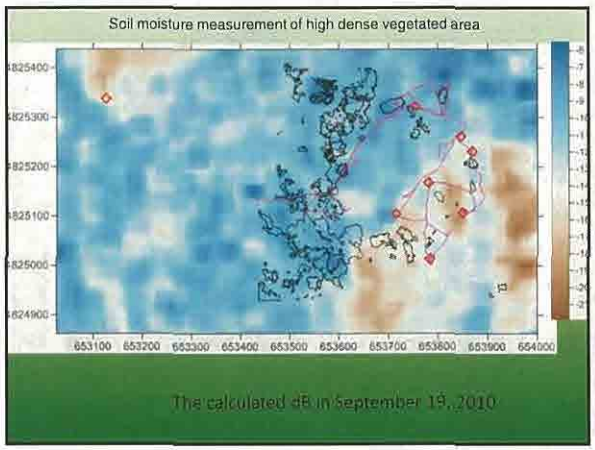

The shadow: > 0.80
The shadow

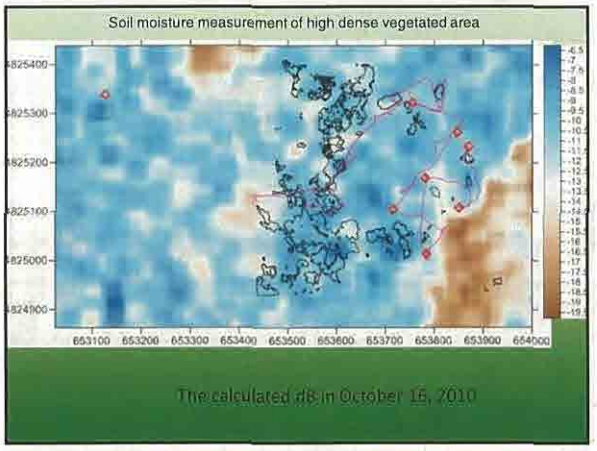

Soil moisture measurement of high dense vegetated area
The calculated dB in June 19, 2010


Soil moisture measurement of high dense vegetated area
The calculated dB in July 6, 2010


Soil moisture measurement of high dense vegetated area
The calculated dB in August 4, 2010







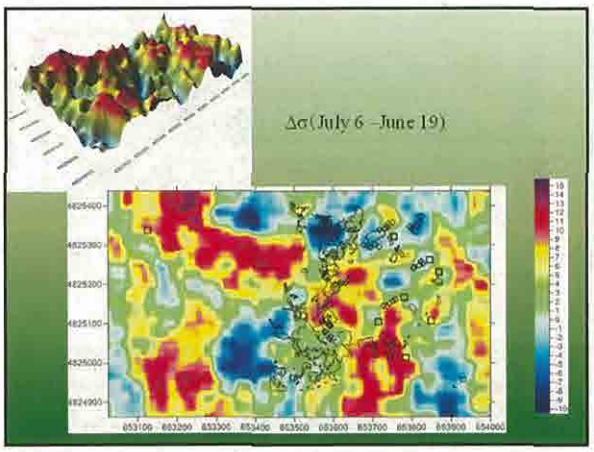
Methodology

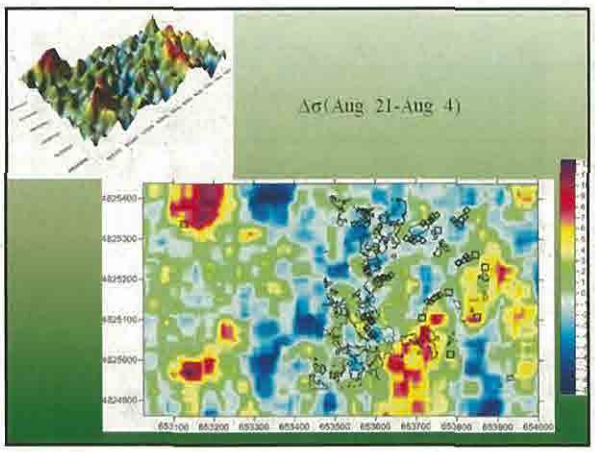
To reduce the effect of roughness on a retrieval of soil moisture, a ratio of backscatter coefficient for wet and dry soil has been calculated. The backscatter coefficient **subtraction** values (September 10th, 2007 and September 15th, 2009) are shows that changes in the soil moisture in the bare soil area were greater than that in mesquite tree ground.

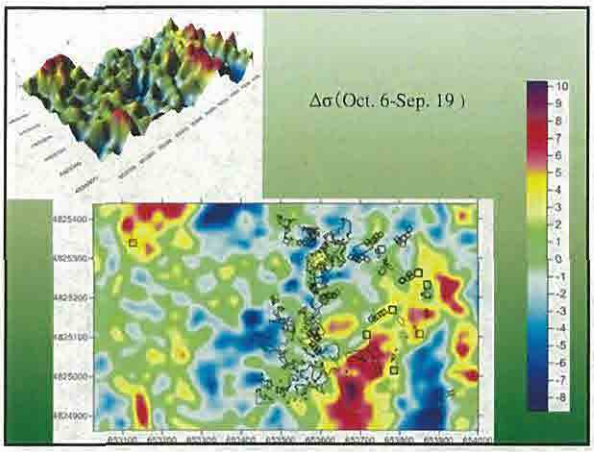
It has been suggested that during two years period (from 2007 to 2009) the mesquite trees are grown up little, because the value of $\Delta\sigma^{t}$ was small positive (0 to + 4) in the mesquite tree area. Contrary, the soil moisture of bare soil in the Atbara River basin showed a great change ($\Delta\sigma^{t}$ was ($+4 < \Delta\sigma^{t}$) and ($0 > \Delta\sigma^{t}$).

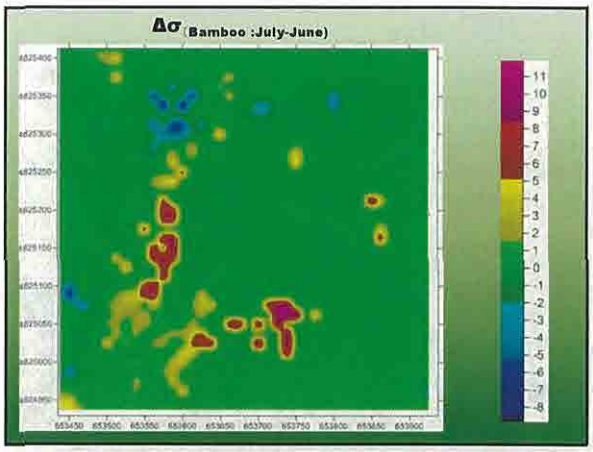
$$\sigma^{t}_{dB} = \tau^{2}\sigma^{t}_{s} + \sigma^{t}_{dv} + \sigma^{t}_{int}$$

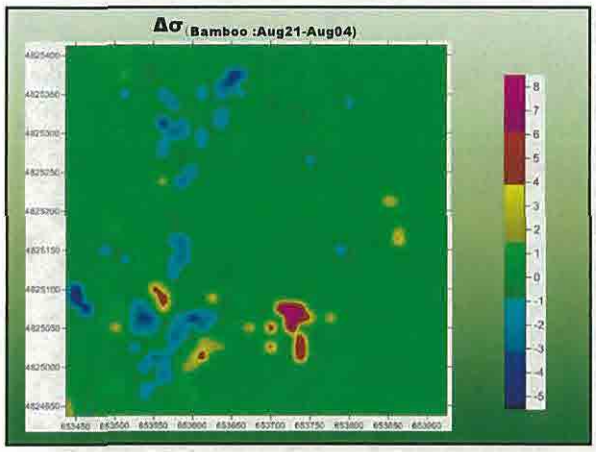
$$\Delta VSM = f_{s}^{-1}(R, m_{v}, t) = \Delta\sigma^{t}_{int} = (\sigma^{t}_{int} - \sigma^{t}_{int}) = \Delta\sigma^{t}_{int}$$

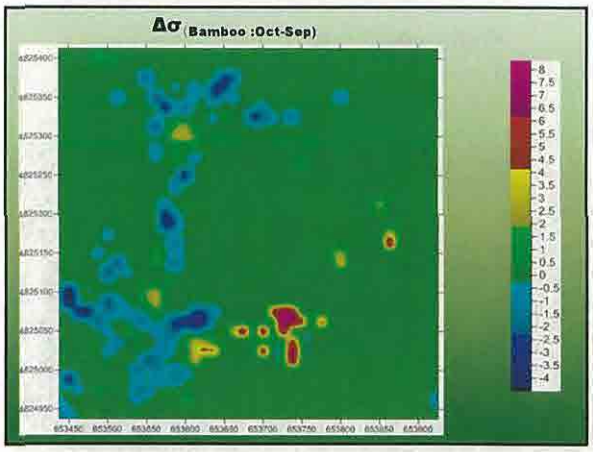


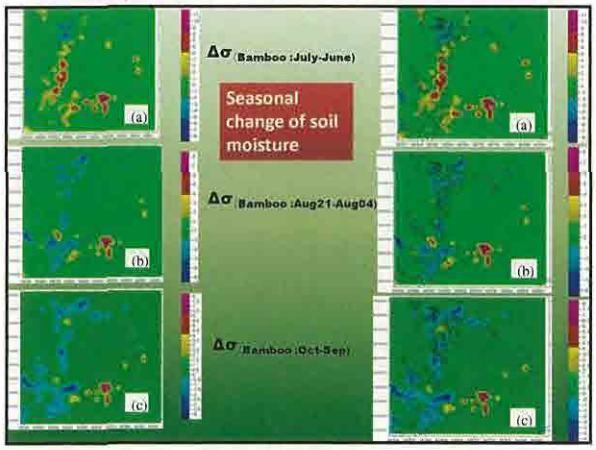


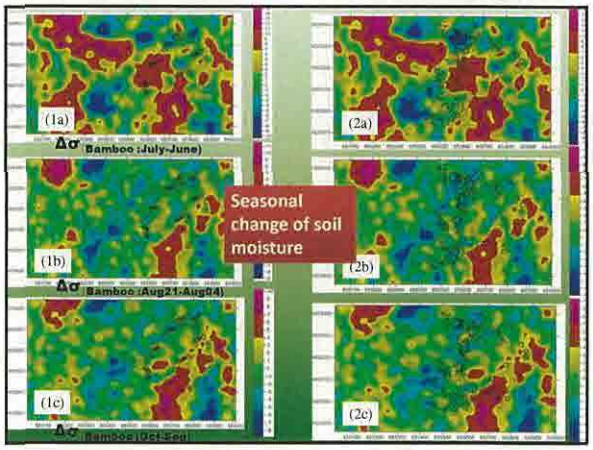

Δσ(Oct. 6-Sep. 19)


Δσ (Bamboo :July-June)


Δσ (Bamboo :Aug21-Aug04)


Δσ (Bamboo :Oct-Sep)


Δσ (Bamboo :July-June)
Seasonal change of soil moisture
Δσ (Bamboo :Aug21-Aug04)
Δσ (Bamboo :Oct-Sep)
(a)
(b)
(c)


(1a)
(2a)
Δσ (Bamboo :July-June)
Seasonal change of soil moisture
(1b)
(2b)
Δσ (Bamboo :Aug21-Aug04)
(1c)
(2c)

Concluding Remarks

a. The microwave satellite backscattering data was used to develop a model for estimating soil moisture in a large area under dense vegetation, which uses differences in microwave backscattering coefficients while taking into consideration the phenology. In the model, the influence of roughness height was successfully removed.

b. This achievement presents significant progress for academic research into estimating soil moisture using microwave backscattering coefficients, as well as for research into mountain areas in general. It is expected that the study results will have practical uses in agriculture, forestry, etc.

Discussion

If vegetation water content can be estimated independently using reflectance in the SWIR, then the retrievals of soil moisture content will be more accurate. The problem is that SWIR reflectance's are dominated by foliar water content and are not affected by stem water content. However, plants often have allometric relationships between foliar and stem mass, so estimation of foliar water content from SWIR reflectance would allow prediction of vegetation water content.

We found that the high dense mesquite trees makes difficulties for the generation of the PALSAR L-band [illegible] However, for areas covered with dense mesquite trees, the soil moisture retrieval is a challenging problem because of complicate scattering mechanisms in the mesquite canopy. So far, additional studies on the estimation of the mesquite biomass using PALSAR L-band microwave data are needed. **In the study, the backscattering coefficient [illegible] values [illegible], where, if are September 16th, 2007 and if are September 15th, 2009, are shown that changes in the soil moisture in the bare soil area were greater than that in vegetated ground in semi-arid region.**

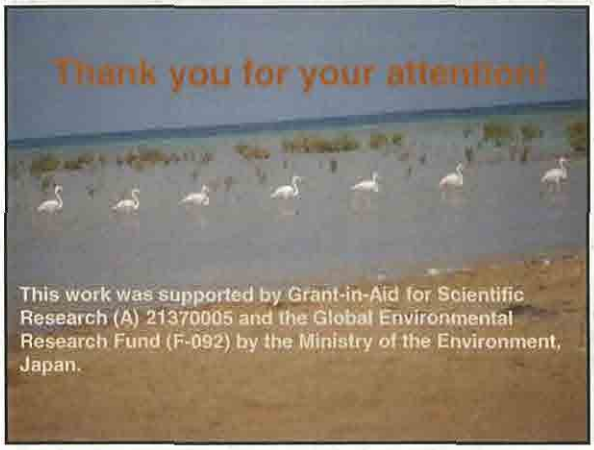
References

Buho Hoshino, Gaku Kudo,Tetsuo Yabuki, Masami Kaneko, Sumiya Ganzorig (2009): Investigation on the water stress in alpine vegetation using Hyperspectral Sensors, ***IEEE IGARSS***.

B. Hoshino, H. Nawata・Jia Ruichen・Karamalla Abdelaziz・K. Yoda (2011): Remote Sensing Methods of Vegetation and Surface Run-off Change in Area, Journal of Rakuno Gakuen Univ. 35(2), 33-43.

Buho Hoshino, Maino Yonemori, Karina Manayeva, Abdelaziz Karamalla, Kiyotsugu Yoda, Mahgoub Suliman, Mohamed Elgamri, Hiroshi Nawata, Yusuke Mori, Shunsuke Yabuki, Shigeto Aida (2011): REMOTE SENSING METHODS FOR THE EVALUATION OF THE MESQUITE TREE (Prosopis juliflora) ENVIRONMENTAL ADAPTATION TO SEMI ARID AFRICA. IEEE IGARSS, (in press).

Buho Hoshino, Abdelaziz Karamalla, Ruichen Jia, Nawata Hiroshi, Abdel Babiker (2010): Remote Sensing Method for Mesquite (Prosopis spp.) Control in Coastal area of Red Sea. 38th COSPAR Scientific assembly of the committee on space research, July 20, 2010. Bremen, Germany.



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