O‘ZBEKISTON MILLIY UNIVERSITETI HUZURIDAGI ILMIY DARAJALAR BERUVCHI DSc.03/27.02.2020.B.01.15 RAQAMLI ILMIY KENGASH ASOSIDAGI BIR MARTALIK ILMIY KENGASH

“TOSHKENT IRRIGATSIYA VA QISHLOQ XO‘JALIGINI MEXANIZATSIYALASH MUHANDISLARI INSTITUTI” MILLIY TADQIQOT UNIVERSITETI

JULIYEV MUXIDDIN KOMILOVICH

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11.00.05 – Atrof-muhitni muhofaza qilish va tabiiy resurslardan oqilona foydalanish

BIOLOGIYA FANLARI DOKTORI (DSc) DISSERTATSIYASI AVTOREFERATI

Toshkent - 2024

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Biologiya fanlari bo‘yicha fan doktori (DSc) dissertatsiyasi mavzusi O‘zbekiston Respublikasi Oliy ta‘lim, fan va innovatsiyalar vazirligi huzuridagi Oliy attestatsiya komissiyasida B2024.1.DSc/B223 raqam bilan ro‘yxatga olingan.

Dissertatsiya “Toshkent Irrigatsiya va Qishloq Xo‘jaligini Mexanizatsiyalash Muhandislari Instituti” Milliy Tadqiqot Universitetida bajarilgan.

Dissertatsiya avtoreferati uch tilda (o‘zbek, ingliz, rus (rezyume)) Ilmiy kengash web-sahifasi (www.nuu.uz) va «ZiyoNet» Axborot-ta’lim portalida (www.ziyonet.uz) joylashtirilgan.

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Yetakchi tashkilot:	**Farg‘ona davlat universiteti**

Dissertatsiya himoyasi O‘zbekiston Milliy universiteti huzuridagi ilmiy darajalar beruvchi DSc.03/27.02.2020. B.01.15 raqamli Ilmiy kengash asosidagi bir martalik Ilmiy kengashning 2024 yil «24» avgust kuni soat 10^{00} dagi majlisida bo‘lib o‘tadi (Manzil: 100174, Toshkent sh., Olmazor tumani, Universitet ko‘chasi 4-uy, O‘zbekiston Milliy universitetining Ekologiya fakulteti binosi, 2-qavat, 203-xona. Tel.: (+99871-246–67–72).

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(2024 yil 2-avgustdagi 19-raqamli reyestr bayonnomasi).

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KIRISH (Fan doktori (DSc) dissertatsiyasi annotatsiyasi)

Dissertatsiya mavzusining dolzarbligi va zarurati. Bugungi kunda dunyoda tuproq degradatsiyasi asosiy ekologik muammolar qatoriga kirgan va hisob-kitoblarga koʻra, umumiy yer maydonining taxminan 25 foizi degradatsiyaga uchragan. Dunyo boʻylab har yili 24 milliard tonna unumdor tuproq eroziya ta'sirida yoʻqolib bormoqda. 2050-yilga borib, dunyo aholisining soni 35 foizga oshib, 9,7 milliardga yetishi taxmin qilinmoqda, bu esa oziq-ovqat, ozuqa, tola va yoqilgʻi kabi qishloq xoʻjaligi mahsulotlariga talabning oshishiga olib keladi[1]. Shu bois, zamonaviy texnologiyalardan foydalangan holda, degradatsiyaga uchragan yerlarni oʻz vaqtida aniqlash, maydonini hisoblash, jarayonni toʻxtatish va oldini olish dolzarb vazifalardan hisoblanadi.

Jahonda tuproq eroziyasi bilan bogʻliq masalalarni yechishda zamonaviy texnologiyalardan foydalanish yoʻnalishi boʻyicha ilmiy izlanishlar olib borilmoqda. Bu borada, tuproq eroziyasini aniqlash, xaritalash, monitoring qilish va modellashtirishda masofadan zondlashning yangi usullaridan yanada samarali foydalanish, tog‘ va tog‘oldi hududlarda eroziya havfi bor yerlarni sun'iy yoʻldosh tasvirlaridan foydalangan holda geoekologik baholash, geoaxborot tizimlarini qoʻllashga qaratilgan ilmiy tadqiqotlarni amalga oshirishga alohida e'tibor qaratilmoqda.

Respublikada soʻnggi yillarda muhofaza qilinadigan tabiiy hududlar, jumladan milliy bogʻlarni monitoring qilish boʻyicha bir qator ilmiy tadqiqotlar olib borilmoqda va bu borada muayyan natijalarga erishilmoqda. Oʻzbekiston Respublikasi Vazirlar Mahkamasining 11.06.2019 yildagi 484-son "2019-2028-yillar davrida Oʻzbekiston Respublikasida biologik xilma-xillikni saqlash strategiyasini tasdiqlash toʻgʻrisida"gi qarorida[2] "...etalon ekotizimlarda bioxilma-xillik komponentlari uchun monitoring olib borishning markaziy boʻgʻinli yagona tizimini yaratish hamda tuproq degradatsiyasi tufayli ushbu komponentlarga salbiy ta'sirlarni zamonaviy geoaxborot texnologiyalari (GAT texnologiyalar) asosida davlat monitoringi axborot ma'lumotlar bazasini yaratish" muhim strategik vazifalardan biri sifatida belgilab berilgan. Bu borada degradatsiyaga uchragan yerlarni masofadan zondlash, GAT texnologiyalari, turli modellashtirish usullarini qoʻllagan holda hududlarning kartografik bazasini yaratish, doimiy yangilab turish, iqlim oʻzgarishiga moslashtirish va tuproq yuvilishining bashorat xaritalarini tuzib, degradatsiya holatining oldini olish chora-tadbirlarini tuzish muhim ahamiyat kasb etadi.

Oʻzbekiston Respublikasi Prezidentining 2017-yil 31-maydagi "Yerlarni muhofaza qilish va ulardan oqilona foydalanish borasida nazoratni kuchaytirish, geodeziya va kartografiya faoliyatini takomillashtirish, davlat kadastrlarini yuritishni tartibga solish chora-tadbirlari toʻgʻrisida"gi PF-5065-son Farmoni[3], Oʻzbekiston Respublikasi Prezidentining 2019-yil 17-iyundagi "Qishloq xoʻjaligida

[1] https://www.thegef.org/what-we-do/topics/land-degradation

[2] Oʻzbekiston Respublikasi Vazirlar Mahkamasining 11.06.2019 yildagi 484-son «2019-2028 yillar davrida Oʻzbekiston Respublikasida biologik xilma-xillikni saqlash strategiyasini tasdiqlash toʻgʻrisida»gi qarori.

[3] Oʻzbekiston Respublikasi Prezidentining 2017-yil 31-maydagi "Yerlarni muhofaza qilish va ulardan oqilona foydalanish borasida nazoratni kuchaytirish, geodeziya va kartografiya faoliyatini takomillashtirish, davlat kadastrlarini yuritishni tartibga solish chora-tadbirlari toʻgʻrisida"gi PF-5065-sonli Farmoni.

yer va suv resurslaridan samarali foydalanish chora-tadbirlari to‘g‘risida”gi PF-5742-son Farmoni[4], O‘zbekiston Respublikasi Prezidentining 2022-yilning 10-iyunidagi “Yerlar degradatsiyasiga qarshi kurashishning samarali tizimini yaratish chora-tadbirlari to‘g‘risi”dagi PQ-277-son Qarori[5], O‘zbekiston Respublikasi Prezidentining 2023-yil 11-sentyabrdagi “O‘zbekiston — 2030” Strategiyasi to‘g‘risida”gi PF-158-son Farmoni[6] va mazkur faoliyatga tegishli boshqa me’yoriy-huquqiy xujjatlarda belgilangan vazifalarni amalga oshirishda ushbu dissertatsiya muayyan darajada xizmat qiladi.

Tadqiqotning respublika fan va texnologiyalari rivojlanishining ustuvor yo‘nalishlariga mosligi. Mazkur tadqiqot respublika fan va texnologiyalarni rivojlantirishning III. “Axborotlashtirish va axborot-kommunikatsiya texnologiyalarini rivojlantirish” va V. “Qishloq xo’jaligi, biotexnologiya, suv muammolari, ekologiya va atrof-muhit muhofazasi” ustuvor yo’nalishlari doirasida bajarilgan.

Dissertatsiya mavzusi bo‘yicha xorijiy ilmiy tadqiqotlar sharhi[7].

Eroziya jarayonlarini baholashda zamonaviy axborot texnologiyalarini joriy qilishga qaratilgan ilmiy-tadqiqotlar jahonning yetakchi ilmiy markazlari va oliy ta’lim muassasalari, Georg-August-Universität Göttingen (Germaniya), Università Ca' Foscari Venezia, Departmentof Environmental Sciences, Informatics and Statistics (Venesiya), Southern Illinois University Carbondale (AQSh), National Research Center Egypt (Misr), University of Agriculture in Krakow, Department of Land Reclamation and Environmental Development (Polsha), Technical University of Denmark (Daniya), Natural Resources Management and Sustainable Development (Angliya), shuningdek Dimo nomidagi Moldovo tuproqshunoslik, agrokimyo va tuproqlarni muhofaza qilish instituti (Moldova), Dokuchaev nomidagi Tuproqshunoslik instituti (Rossiya), Lomonosov nomidagi Moskva davlat universiteti, Timiryazev nomidagi Rossiya davlat agrar universiteti, Uspanov nomidagi Tuproqshunoslik va agrokimyo instituti (Qozog‘iston), Tuproqshunoslik va agrokimyo ilmiy-tadqiqot instituti (O‘zbekiston) tomonidan olib borilmoqda.

Tog‘ tuproqlarida kechadigan eroziya jarayonlarini masofadan zondlash va geoaxborot tizimlarini qo‘llashga oid jahonda olib borilgan tadqiqotlar natijasida qator, jumladan, quyidagi ilmiy natijalar olingan: tuproq xaritalarini masofaviy zondlash usullari yordamida tuproq qoplami tasnifiga aniqlik kiritishi isbotlangan (Southern Illinois University Carbondale); tog‘ hududlari relyefini tavsiflovchi xaritalar tuzish jarayonida GAT texnologiyalarining muhimligi ko‘rib chiqilgan (National Research Center Egypt); tog‘li va tog‘oldi maydonlarda kechuvchi eroziya jarayonlari relyefning raqamli modeli asosiga tuzilgan qatlamlar xususiyatlariga bog‘liqligi aniqlangan (Natural Resources Management and Sustainable

[4]O‘zbekiston Respublikasi Prezidentining 2019-yil 17-iyundagi “Qishloq xo‘jaligida yer va suv resurslaridan samarali foydalanish chora-tadbirlari to‘g‘risida”gi PF-5742-son Farmoni.

[5]O‘zbekiston Respublikasi Prezidentining 2022-yilning 10- iyunidagi “Yerlar degradatsiyasiga qarshi kurashishning samarali tizimini yaratish chora-tadbirlari to‘g‘risi”dagi PQ-277-son Qarori.

[6]O‘zbekiston Respublikasi Prezidentining 2023-yil 11-sentyabrdagi “O‘zbekiston — 2030” Strategiyasi to‘g‘risida”gi PF-158-son Farmoni.

[7]Dissertasiyaning mavzusi bo’yicha ilmiy tadqiqotlar sharhi http://www.works.doklad.ru, http://www.km.ru, www.dissercat.com, researechget.net, http://www.fundamental-research.ru, www.webofscience.com va boshqa manbalar asosida ishlab chiqilgan.

Development); masofadan zondlash va GAT texnologiyalarining tuproq eroziyasiga oid tadqiqotlarda degradatsiya turlarini aniqlashda muhimligi isbotlangan (N.Dimo nomidagi Moldova tuproqshunoslik, agrokimyo va tuproqlarni muhofaza qilish instituti).

Bugungi kunda dunyoda tog‘ va tog‘oldi hududlarida tarqalgan tuproqlarda kechuvchi eroziya jarayonlarini GAT texnologiyalari va masofadan zondlash usullari yordamida baholash bo‘yicha bir qator, jumladan, quyidagi ustuvor yo‘nalishlarda tadqiqotlar olib borilmoqda: tuproq eroziyasini baholashda va bashorat qilishda turli modellardan foydalanish va modellarni iqlim o‘zgarishi sharoitlariga moslashtirish; tuproqlarning eroziyaga xavfliligini aniqlashda turli omillarni o‘z ichiga olgan xaritalar bazasini yaratish; eroziya jarayonlarini monitoring qilish va xaritalashda yuqori aniqlikdagi masofadan zondlash tasvirlaridan foydalanish uslublarini takomillashtirish.

Muammoning o‘rganilganlik darajasi. Dunyoda klassik eroziyashunos olimlar tomonidan eroziya jarayonlarining kelib chiqish qonuniyatlari, jumladan, eroziyani yuzaga keltiruvchi omillar, eroziya jarayonlarining tuproqning xossa xususiyatlariga ta’siri, uning unumdorligini tiklash va uni muhofaza qilish bo‘yicha uzoq yillar davomida ko‘plab ma‘lumotlar to‘plangan. Jumladan, B.Pradhan, A.Arabameri, M.Zaslavsikiy, G.Surmach, G.Shvebs, V.Gussak, M.Kuznetsov, M.Doshanov, F.Kocherga, A.Xanazarov, S.Elyubaev, X.Maxsudov, L.Gafurova, G.Djalilova va boshqalarning ishlarini keltirib o‘tishimiz mumkin. Lekin tabiatni muhofaza qilish maqsadida alohida muhofaza qilinadigan tog‘ va tog‘oldi hududlarda kechuvchi eroziya jarayonlarini geofazoviy tahlil qilish va tuproq eroziyasini modellashtirish usullarini amalga oshirish, ularni takomillashtirish ya’ni masofaviy zondlash ma’lumotlari bilan yer usti ma’lumotlariga asoslangan zamonaviy yondashuvlarni joriy etish borasidagi ilmiy izlanishlar yetarlicha amalga oshirilmagan.

Tadqiqotining dissertatsiya bajarilgan oliy ta’lim muassasasining ilmiy-tadqiqot ishlari rejalari bilan bog‘liqligi. Dissertatsiya tadqiqoti MUNIS/CS/CQS/6 “Modernizing Uzbekistan National Innovation System (MUNIS) loyihasi (2022-2023), 609574-EPP-1-2019-1-IT-EPPKA2-CBHE-JP - “Markaziy Osiyoda madaniy meros aktivlariga ekologik xavfni baholash va kamaytirish” (2020-2024) loyihalari hamda Toshkent irrigatsiya va qishloq xo‘jaligini mexanizatsiyalash muhandislari instituti, Milliy tadqiqot universiteti Ekologiya va suv resurslarini boshqarish kafedrasi va O‘zbekiston Milliy universiteti Biologiya fakulteti Tuproqshunoslik kafedrasi ilmiy-tadqiqot ish dasturlari doirasida bajarilgan.

Tadqiqotning maqsadi tog‘ va to‘goldi hududlarida eroziya jarayonlarini geoaxborot texnologiyalari va masofadan zondlash usullari asosida baholash va tuproq eroziyasi jarayonlarini modellashtirish usullarini takomillashtirishdan iborat.

Tadqiqotning vazifalari:

MDH mamlakatlari tajribalari asosida mavzuga oid ishlarni tahlil qilish va ularga ko‘ra tog‘ va tog‘oldi hududida kechuvchi eroziya jarayonlarini aniqlash, baholash va modellarini yaratishda geofazoviy tahlil uslubining strategiyasini ishlab chiqish;

RUSLE modelini qo‘llash uchun eroziya jarayonlariga sabab bo‘luvchi tabiiy omillarni modelga moslashtirish maqsadida hududning tabiiy-iqlim sharoitlarini tahlil qilish;

iqlim o‘zgarishi sharoitiga bog‘liq holda tadqiqot obyekti o‘simlik va yer qoplami bo‘yicha ma’lumotlarni monitoring qilish maqsadida davriy sun’iy yo‘ldosh tasvirlarining turli indekslarini hisoblash asosida geofazoviy tahlil qilish;

MCDA modelini qo‘llash uchun asos bo‘luvchi birlamchi kartografik, gidrometereologik, hududda tarqalgan yer osti suvlari haqidagi ma’lumotlar va talabga javob beruvchi sun’iy yo‘ldosh tasvirlarini geofazoviy tahlil qilish;

OBIA (Object-Based Image Analysis) modelini qo‘llash uchun asos bo‘luvchi tadqiqot obyektining yuqori aniqlikdagi sun’iy yo‘ldosh tasvirlarini tanlash va geofazoviy tahlili orqali eroziya xavfi mavjud hududlarni ajratish va tematik xaritalarini yaratish;

tadqiqot obyektiga moslashtirilgan RUSLE modeli asosida eroziya jarayonlari natijasida yillik tuproq yo‘qotilishi ma’lumotlari aks ettirilgan tematik xaritalar yaratish.

Tadqiqotning obyekti sifatida Ugom-Chotqol milliy bog‘i tog‘ va tog‘oldi hududida tarqalgan tuproqlar va o‘simlik qoplami, yer osti suvlari va eroziya havfi bor tuproqlar olingan.

Tadqiqotning predmetini tog‘ va tog‘oldi tuproqlari, yer qoplami holatining o‘zgarish dinamikasi, yer osti suvlari va eroziya jarayonining bog‘liqligi, turli tematik xaritalar, eroziya jarayonlarini xaritalash va modellashtirish tashkil etgan.

Tadqiqotning usullari. Dala va laboratoriya tadqiqotlari umumiy qabul qilingan uslublar bo‘yicha amalga oshirilgan. Ilmiy-tadqiqotlar masofaviy zondlash usullari va GAT texnologiyasidan foydalangan holda amalga oshirildi. Jumladan, tadqiqot obyekti yer osti suv manbalari va tuproq eroziyasi jarayonlari o‘rtasidagi munosabatlar MCDA (Multi-Criteria Decision Analysis) modeli, sun’iy yo‘ldosh tasvirlarining geofazoviy tahlili OBIA (Object-Based Image Analysis) modeli, eroziya jarayonlari natijasida yillik tuproq yo‘qotilishi RUSLE modeli yordamida amalga oshirilgan, shu bilan birga o‘simlik indeksi (NDVI), yer qoplamining o‘zgarishi (LULC) indekslari asosida hisoblangan. Masofadan zondlash ma‘lumotlari GAT texnologiyasining QGIS, Google Earth, Google Earth Engine, ArcGIS va boshqa dasturlari yordamida qayta ishlandi.

Tadqiqotning ilmiy yangiligi quyidagilardan iborat:

ilk bor oxirgi 60 yil davomida MDH mamlakatlarida olib borilgan tuproq eroziyasiga oid ilmiy, ular asosida bibliometrik ma’lumotlar bazasi yaratilgan tog‘ va tog‘oldi hududida kechuvchi eroziya jarayonlarini aniqlash, baholash va modellarini yaratishda geofazoviy tahlil usulining strategiyasi ishlab chiqilgan;

Ugom-Chotqol milliy bog‘ida iqlim o‘zgarishi sharoitida hududning o‘simlik dunyosi, yer qoplami ko‘rsatkichlarining 20 yil mobaynida o‘zgarishlarini aniqlashda sun’iy yo‘ldosh tasvirlarining vegetatsion indekslari hisoblari asosida geofazoviy tahlildan foydalanish yuqori aniqlikdagi ma’lumotlar berishi aniqlangan;

ilk bor tadqiqot obyektida eroziya jarayonlarining geofazoviy tahlilini o’tkazish va modellarni aprobatsiya qilish maqsadida yer osti suv manbalari va tuproq eroziyasi jarayonlari o‘rtasidagi munosabatlarni aniqlashda, ko‘p mezonli qarorlarni tahlil qilishda MCDA modelining afzalligi va imkoniyatlari takomillashtirilgan;

ilk bor tadqiqot obyektida yuqori aniqlikdagi sun’iy yo‘ldosh tasvirlari va OBIA (Object-Based Image Analysis) modeli orqali eroziya jarayonlarini avtomatik aniqlash usuli tatbiq qilingan va imkoniyatlari baholangan;

geofazoviy tahlilga asoslangan RUSLE modeli yordamida eroziya jarayonlarini modellashtirish maqsadida tadqiqot obyektining spetsifik xususiyatlarini inobatga olgan holda RUSLE modelining parametrlari moslashtirilgan va uning imkoniyatlari takomillashtirilgan.

Tadqiqotning amaliy natijalari quyidagilardan iborat:

tog‘ va tog‘oldi hududida kechuvchi eroziya jarayonlarini aniqlash, baholash va modellarini yaratish usuli strategiyasi yordamida eroziya jarayonlarini modellashtirishda asos bo‘luvchi baza yaratilgan;

geofazoviy tahlil asosida sun’iy yo‘ldosh tasvirlariga ishlov berish, ya’ni o‘simlik indeksi (NDVI), yer qoplamining o‘zgarishi (LULC) va yog‘ingarchilik ko‘rsatkichlari hisoblangan va hudud uchun tematik xaritalar ishlab chiqilgan;

MCDA modeli yordamida tadqiqot obyekti yer osti suv manbalari va tuproq eroziyasi jarayonlari o‘rtasidagi munosabatlarni aks ettiruvchi tematik xaritalar yaratilgan va ular asosida potensial yer osti suv manbalari hosil bo‘ladigan hududlar tasniflangan;

avtomatik xaritalash imkoniyatiga ega OBIA (Object-Based Image Analysis) modeli yordamida tadqiqot obyektining yuqori aniqlikdagi sun’iy yo‘ldosh tasvirlarining geofazoviy tahlili orqali eroziya xavfi mavjud hududlar ajratilgan va tematik xaritalar yaratilgan;

tabiiy iqlim sharoitini inobatga olgan holda RUSLE modelining asosi bo‘lgan eroziya jarayonlarini keltirib chiqaruvchi omillar ushbu ma’lumotlarga ko‘ra moslashtirilgan va ular asosida eroziya jarayonlari natijasida yillik tuproq yo‘qotilishi ma’lumotlari aks ettirilgan tematik xaritalar yaratilgan.

Tadqiqot natijalarining ishonchliligi. Tadqiqot natijalarining ishonchliligi umume’tirof etilgan tadqiqot usullari va olingan nazariy natijalarni amaliy ma’lumotlar bilan tasdiqlash, tadqiqot natijalarini o‘xshash yo‘nalishdagi boshqa mualliflarning natijalari bilan taqqoslash va tadqiqot natijalarini amaliyotga tatbiq etish bilan asoslanadi.

Tadqiqot natijalarining ilmiy va amaliy ahamiyati. Tadqiqot natijalarining ilmiy ahamiyati o‘rganilgan hududda kechayotgan eroziya jarayonlarining monitoringini amalga oshirishda turli modellar imkoniyatlaridan foydalanilgan holda yerni masofadan zondlash va geofazoviy tahlil qilish usullarini integratsiya qilish bilan tog‘li hududlarda kechadigan eroziya jarayonlarini aniqlash, baholashda va modellarini yaratishda aniq axborotlar bilan ta’minlab berish bilan izohlanadi.

Tadqiqot natijalarining amaliy ahamiyati yaratilgan tematik xaritalar eroziyaga uchragan hududlar holatini yaxshilash bo‘yicha bir qator asoslangan ekologik tadbirlarni ishlab chiqishda, o’simlik dunyosi holatini tahlil qilish va uni muhofaza qilishga qaratilgan chora-tadbirlarni ishlab chiqishga xizmat qiladi.

Tadqiqot natijalarining joriy qilinishi. O‘zbekistonning tog‘li va tog‘oldi hududlarida eroziya jarayonlarini modellashtirishning nazariy asoslari va metodikasi bo‘yicha olib borilgan ilmiy natijalar asosida:

Scopus ma’lumotlar bazasi asosida tuproq eroziyasi mavzusiga doir ingliz tilida chop etilgan maqolalar bazasi va statistik tahlil qilish usuli shakllantirilgan va

ushbu baza “O‘zbekiston milliy innovatsion tizimini modernizatsiya qilish” loyihasini amalga oshirish guruhi doirasida olib borilayotgan “English for Science” dasturi orqali amaliyotga joriy etilgan (O‘zbekiston Respublikasi Oliy ta’lim, fan va innovatsiyalar vazirligining ma’lumotnomasi). Natijada, ushbu bibliometrik ma’lumotlar bazasi yosh tadqiqotchilarning atrof-muhitni muhofaza qilish va tabiiy resurslardan oqilona foydalanish yo‘nalishida olib borayotgan tadqiqot ishlarida eroziya jarayonlarini aniqlash, baholash, modellashtirish va ushbu jarayonlarga qarshi tuproqlarni muhofaza qilish bo‘yicha chora-tadbirlarni ishlab chiqishda dunyo tajribasini o‘zlashtirish orqali tadqiqot metodologiyasini ishlab chiqishda xizmat qilgan;

MCDA (Multi-Criteria Decision Analysis) modeli yordamida yaratilgan tematik xaritalar Geologiya fanlari universiteti tarkibidagi Gidrogeologiya va injenerlik geologiyasi instituti davlat muassasasi amaliyotiga joriy etilgan (O‘zbekiston Respublikasi Tog‘-kon sanoati va geologiya vazirligi 2023-yil 12-dekabrdagi 08-4522 sonli ma’lumotnomasi). Natijada tadqiqot obyekti yer osti suv manbalari va tuproq eroziyasi jarayonlari o‘rtasidagi munosabatlarni aks ettiruvchi potensial yer osti suv manbalari hosil bo‘ladigan hududlarni tasniflash imkonini bergan;

OBIA (Objest-Based Image Analysis) modeli imkoniyatlaridan foydalanilgan holda yuqori aniqlikdagi GeoEye-1 sun’iy yo‘ldosh tasvirlarining geofazoviy tahlili asosida yaratilgan tadqiqot obyektining eroziya xavfi mavjud hududlari aks ettirilgan tematik xaritalar Geologiya fanlari universiteti tarkibidagi Gidrogeologiya va injenerlik geologiyasi instituti davlat muassasasi amaliyotiga joriy etilgan (O‘zbekiston Respublikasi Tog‘-kon sanoati va geologiya vazirligi 2023-yil 12-dekabrdagi 08-4522 sonli ma’lumotnomasi). Natijada ushbu ishlanma tog‘ va tog‘oldi hududlarida kechuvchi eroziya jarayonlarini avtomatik xaritalash imkonini bergan;

RUSLE modeli asosida yaratilgan eroziya jarayonlarini keltirib chiqaruvchi omillar va ushbu jarayonlar tufayli yillik tuproq yo‘qotilishi ma’lumotlari aks ettirilgan tematik xaritalar O‘zbekiston Respublikasi ekologiya, atrof-muhitni muhofaza qilish va iqlim o‘zgarishi vazirligi tarkibidagi Atrof-muhit va tabiatni muhofaza qilish texnologiyalari ilmiy-tadqiqot instituti amaliyotiga joriy qilingan (O‘zbekiston Respublikasi ekologiya, atrof-muhitni muhofaza qilish va iqlim o‘zgarishi vazirligining 2023 yil 29-noyabrdagi 03-03/3-7523-sonli ma’lumotnomasi). Natijada eroziyaga uchragan tuproqlarning holatini yaxshilash bo‘yicha ekologik asoslangan tuproqni muhofaza qilish chora-tadbirlarini to‘g‘ri qo‘llash, lalmi yerlarda ekin turlarini to‘g‘ri tanlash va joylashtirishda xizmat qilgan;

Landsat-5 TM va Landsat 8 (OLI & TIRS) sun’iy yo‘ldoshlari tasvirlarining geofazoviy tahlil asosida yaratilgan o‘simlik indeksi (NDVI), yer qoplamining o‘zgarishi (LULC) va yog‘ingarchilik ko‘rsatkichlari aks ettirilgan tematik xaritalari O‘zbekiston Respublikasi ekologiya, atrof-muhitni muhofaza qilish va iqlim o‘zgarishi vazirligi tarkibidagi Atrof-muhit va tabiatni muhofaza qilish texnologiyalari ilmiy-tadqiqot instituti amaliyotiga joriy qilingan (O‘zbekiston Respublikasi ekologiya, atrof-muhitni muhofaza qilish va iqlim o’zgarishi vazirligining 2023 yil 29-noyabrdagi 03-03/3-7523-sonli ma’lumotnomasi). Natijada, ushbu tematik xaritalar Ugom-Chotqol hududining 575 ming gektar

maydonida tarqalgan oʻsimlik dunyosi va yer qoplamining holatini tahlil qilish va uni muhofaza qilishga qaratilgan chora-tadbirlarni ishlab chiqish uchun xizmat qilgan.

Tadqiqot natijalarining aprobatsiyasi. Mazkur tadqiqot natijalari 4 ta xalqaro va 2 ta respublika miqyosida oʻtkazilgan ilmiy-amaliy anjuman va forumlarda muhokama qilingan.

Tadqiqot natijalarining e'lon qilinganligi. Dissertatsiya mavzusi boʻyicha jami 22 ta ilmiy ish chop etilgan, shulardan, Oʻzbekiston Respublikasi Oliy attestatsiya komissiyasining doktorlik dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan ilmiy nashrlarda 16 ta maqola, jumladan, 7 tasi shulardan Scopus va Web of Science ma'lumotlar bazalarida va 11 respublika jurnallarda nashr etilgan.

Dissertatsiyaning tuzilishi va hajmi. Dissertatsiya kirish, 7 bob, xulosa, foydalanilgan ilova va adabiyotlar roʻyxatidan iborat. Dissertatsiyaning umumiy hajmi 172 betni tashkil etadi.

DISSERTATSIYANING ASOSIY MAZMUNI

Kirish qismida oʻtkazilgan tadqiqotlarning Oʻzbekiston va jahonda zaruriyati hamda dolzarbligi koʻrsatilgan, ishning maqsadi va vazifalari, obyekt va predmetlari shakllantirilib, respublika fan va texnologiyalari rivojlanishining ustuvor yoʻnalishlariga mosligi koʻrsatilgan, tadqiqotning ilmiy yangiligi va amaliy natijalari ochib berilgan. Olingan natijalarning nazariy va amaliy ahamiyatlari asoslangan, ishning aprobatsiyasi va natijalarining joriy qilinishi, hajmi va tuzilishi boʻyicha ma'lumotlar berilgan.

Dissertatsiyaning **«Analyzing soil erosion trends in CIS countries through scopus database» (Scopus ma'lumotlari bazasi orqali MDH mamlakatlarida tuproq eroziyasi boʻyicha trendni tahlil etish)** deb nomlangan birinchi bobida tadqiqot maqsadi va vazifalaridan kelib chiqqan holda, 61 yil davomida Scopus bazasida tuproq eroziyasi mavzusida chop etilgan maqolalarning bibliometrik tahlili berilgan. Ushbu bobda eroziya jarayonlari va sabablari (tadqiqotlar koʻpincha tuproq eroziyasiga olib keladigan omillarni, jumladan, qishloq xoʻjaligi amaliyotlari, iqlim oʻzgarishi, yerdan foydalanish va topografiyaning oʻzgarishini oʻrganish); eroziyani modellashtirish (tadqiqotchilar tuproq eroziyasini bashorat qilish va zaif hududlarni aniqlash uchun turli modellarni ishlab chiqish); eroziyani kuzatish va baholash (masofadan zondlash, GAT va dala oʻlchovlari kabi tuproq eroziyasini kuzatish uchun foydalaniladigan usullar va vositalardan foydalanish); tuproqni saqlash va degradatsiya jarayonlarini yumshatish (eroziyaga qarshi kurash choralarini koʻrib chiqish); qishloq va suv resurslariga ta'siri (tuproq eroziyasining ekinlar hosildorligi va suv sifatiga ta'sirini muhokama qilish, yerni barqaror boshqarish amaliyotiga joriy qilish); muammoni hal qilishdagi xalqaro hamkorlik, muammoni hal qilishda yuzaga keladigan qiyinchiliklar va kelajakdagi yoʻnalishlarga e'tibor berish boʻyicha ma'lumotlar berilgan. Ushbu bob boʻyicha quyidagi xulosalarni keltirish mumkin: integratsiyalashgan yondashuvlarni joriy qilish (tuproq eroziyasi dinamikasini yaxlit tushunish uchun tuproqshunoslik, gidrologiya, agronomiya va iqlimshunoslikni birlashtirgan fanlararo tadqiqotlar zarur); imkoniyatlarni oshirish

(oʻqitish va salohiyatni oshirish tashabbuslari tadqiqotchilar va amaliyotchilarning tuproq eroziyasini boshqarish boʻyicha bilimlarini oshirish); iqlim oʻzgarishiga moslashish (iqlim oʻzgarishi kuchayib borar ekan, tadqiqot iqlim oʻzgarishi va tuproq eroziyasi oʻrtasidagi oʻzaro taʼsirni oʻrganishi, moslashish va chidamlilik strategiyalarini aniqlash).

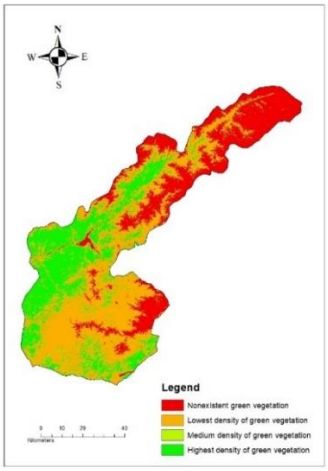
Dissertatsiyaning **“Physical and geographical conditions of Ugam-Chatkal national park” (Ugom-Chotqol milliy bogʻining fizik-geografik sharoitlari) va “Interaction of soil erosion with groundwater and climate change issues” (Tuproq eroziyasining yer osti suvlari bilan oʻzaro taʼsiri va iqlim oʻzgarishi muammolari)** deb nomlangan ikkinchi va uchinchi boblari Oʻzbekistonda tuproq eroziyasi muammolari, keltirib chiqaruvchi omillar va tuproq eroziyasining iqlim oʻzgarishi va yer osti suvlari bilan bogʻliqligiga bagʻishlangan. Ushbu bobda tuproq eroziyasining oʻzaro taʼsirining bir qancha jihatlari tahlil qilingan. Oʻzbekistondagi tuproq eroziyasi muammolari qisqacha tahlili, tuproq eroziyasining turlari, tuproq eroziyasini keltiruvchi omillar haqida maʼlumotlar keltirilgan. Tadqiqot obʼyekti lyossimon tub jinslardan shakllangan boʻlib, dengiz sathidan balandlik oshgan sari lyossimon togʻ jinslarning qalinligi kamayib borishi, prolyuvial, delyuvial-prolyuvial yotqiziqlar bilan tasniflanishi kuzatilgan. Tadqiqot obʼyektining tabiiy sharoitlari eroziya jarayonlarining jadal borishiga taʼsir qiluvchi asosiy omillardan biri boʻlib, hududning notekis relyef sharoiti tuproqning yuvilishiga, natijada oʻsimliklarning oʻsishi va rivojlanishi uchun muhim boʻlgan ozuqa moddalariga boy ustki qatlamning yoʻqotilishiga, bu esa oʻsimliklarning yangilanishiga toʻsqinlik qilishiga, milliy bogʻdagi biologik xilma-xillik va ekologik muvozanatni buzilishiga sabab boʻladi. Shu bilan bir qator notekis relyef sharoitida shakllangan qiyaliklarining kuchli nishabligi, ekspozitsiyasi, bahorgi va kuzgi-qishki mavsumlarda yogʻadigan yogʻingarchilik sababli tuproqlarning yuvilishi va oʻpirilishi oqibatida qiyaliklarning beqarorlashishi ularning strukturaviy yaxlitligini zaiflashtirishi, tabiiy muhitga tahdid soladigan halokatli hodisalar ehtimolini oshirishi bilan izohlanadi. Tadqiqot obʼyektining iqlim sharoiti spetsifik xususiyatlarga ega boʻlib, dengiz sathidan balandlik oshishi bilan havo haroratining birmuncha past boʻlishi, yogʻinlar miqdorining ortishiga bogʻliq ravishda oʻsimlik, tuproq tiplarini oʻzgarishiga sabab boʻladi.

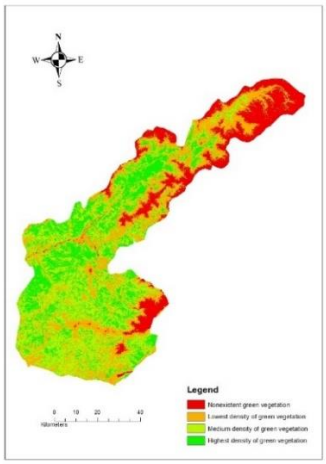
Dissertatsiyaning **“Transforming landscapes: land use and cover change analysis in Ugam-Chatkal national park” (Landshaft oʻzgarishi: Ugom-Chotqol milliy bogʻida yer qoʻplami oʻzgarishi tahlili)** deb nomlangan toʻrtinchi bobida Ugom-Chotqol milliy bogʻi tuproq va oʻsimlik qoplamining 20 yillikdagi oʻzgarishlarini bir qancha mezonlarga koʻra aniqlash jarayonlarini amalga oshirish davomida olingan tahlil natijalari keltirilgan. Tadqiqotlar davomida 2000-2020 yillar orasidagi 10% gacha bulutlilikka ruxsat berilgan, iyun oyida olingan Landsat-5 TM va Landsat 8 (OLI & TIRS) rusumdagi sunʼiy yoʻldoshlari Earth explorer platformasidan foydalangan holda sunʼiy yoʻldosh tasvirlarini yuklab olingan (1-jadval, 1-rasm). Landsat sunʼiy yoʻldosh tasvirlari 30x30 m oʻlchamlari bilan sakkizta 30 m aks ettirish diapazoni, bitta 15 m panxromatik va ikkita 100 m termal diapazonga ega.

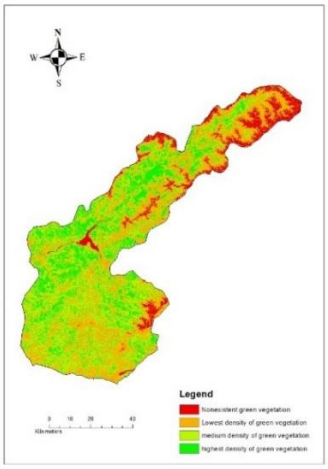
1-jadval

Tadqiqot obyektida yerdan foydalanish va yer qoplamini baholash natijalari

Sinflar	Yer maydoni (κv km)		
	2000	2010	2020
Qor	3200.3	1513.96	587.019
Bosh yerlar	1686.68	2239.74	2273.74
Suv	54.3852	73.8441	45.8622
O‘simliklar qoplami	1684.19	2798	3741.37







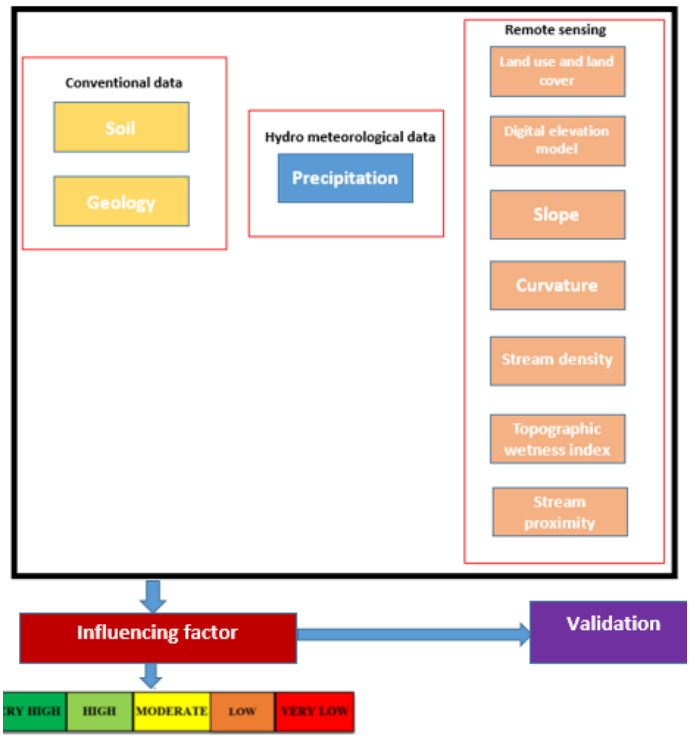
a) 2000 yil b) 2010 yil v) 2020 yil

1-rasm. Tadqiqot obyektining NDVI xaritasi

Global iqlim o‘zgarishining Markaziy Osiyo mintaqasiga ta’siri yil sayin ortib bormoqda va bu dinamikani tahlil qilishda masofaviy zondlash va geografik axborot tizimlarining ahamiyati ortib borayotganini ta’kidlamoqda. Tadqiqot olib borilgan davrda milliy bog‘da qor qoplamining qisqarishi kuzatildi. Antropogen ta’sirlar bog‘ning janubiy-g‘arbiy hududlarida bo‘sh yerlarning kengayishiga olib keldi. Yillik yog‘ingarchilikning o‘zgarishi, asosan, shimoliy mintaqada o‘sish, janubiy hududlarda esa pasayish holatini ko‘rsatdi.

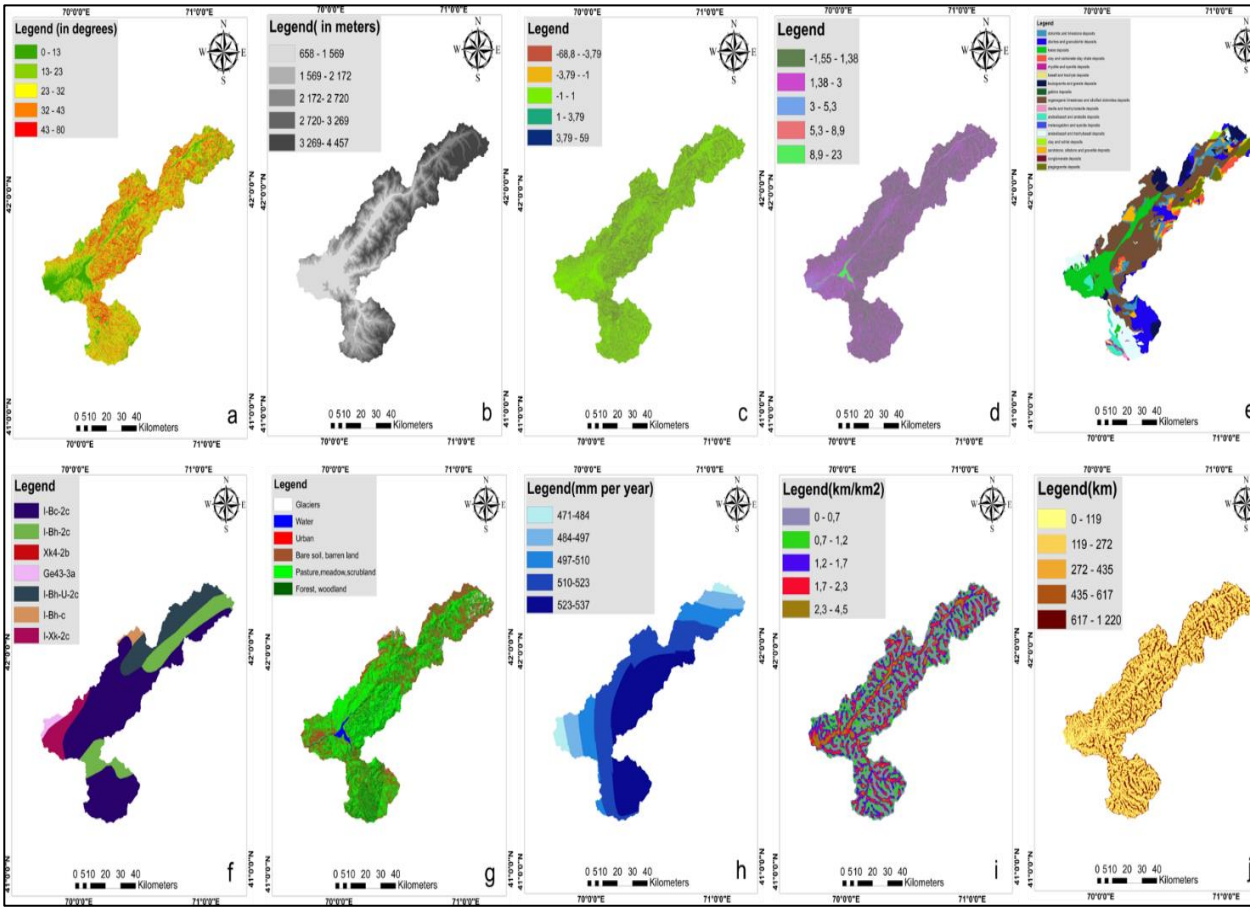
Dissertatsiyaning **“Evaluating groundwater potential: precision of geospatial data in multi-criteria decision analysis”** (Yer osti suvlari potensialini baholash: ko‘p mezonli qarorlar tahlilida geofazoviy ma’lumotlarning aniqligi) deb nomlangan beshinchi bobida tadqiqot obyektining gidrologik, geologik, geofizik va geomorfologik vositalarni o‘z ichiga olgan yer osti suv resurslarini xaritalashda ko‘pincha ishlatiladigan an’anaviy usullarni qimmatligi, vaqt va mehnat talab qilishi, ushbu ishni amalga oshirishda keng imkoniyatlar yaratuvchi yondashuvlar - yer osti suvlari potensial zonalarini tahlil qilish uchun masofaviy zondlash va GAT texnologiyasidan foydalanish mumkinligi qayd etilgan. Tadqiqotlar davomida

sun’iy yo‘ldosh tasvirlari to‘g‘ridan-to‘g‘ri yer osti suvlari hududlarini ko‘rsatmasada, masofadan zondlash tahlili yer osti suv qatlami mavjudligini keyingi ko‘p mezonli tahlil qilish uchun ishlatilishi mumkinligi kuzatilgan. Ushbu jarayonni bajarishda tadqiqot obyektida mavjud buloqlarning joylashuvi va geofazoviy texnikadan foydalangan holda yer osti suvlari potensial zonalarini belgilash uchun ta’sir etuvchi ko‘p mezonli qarorlarni tahlil qilish vositasining to‘g‘riligini o‘rganishga qaratilgan. Yer osti suvlarining umumiy tematik qatlamlari suvli qatlamlarning mavjudligini aniqlash uchun tayyorlangan, ya’ni raqamli balandlik modeli (DEM), qiyalik, tuproq xaritasi, geologik xarita, yerdan foydalanish yer qoplami (LULC), oqim yaqinligi, oqim zichligi, egrilik, topografik namlik indeksi (TWI) va asos bo‘luvchi sun’iy yo‘ldosh ma’lumotlari va boshqa birlamchi manbalardan olingan yog‘ingarchilik qatlamlari ArcGIS va ERDAS Imagine dasturlarida ko‘p mezonli qarorlarni tahlil qilish vositasi uchun muhim qatlamlar sifatida qayta ishlangan (2-rasm).



2-rasm. Yer osti suvlari potentsiyalini xaritalash metodologiyasining sxemasi

Ko‘p mezonli qarorlarni tahlil qilish vositasi, xususan, ta’sir etuvchi omil usuli, GATda yer osti suvlari potensial zonalarini belgilash uchun keng qo‘llaniladi. MCDA vositasi Saati tomonidan ishlab chiqilgan va barcha tematik qatlamlarni ularning og‘irlik qiymatiga ko‘ra birlashtirishga yordam beradi. Tadqiqotlar davomida quyidagi formuladan foydalangan holda yakuniy xaritani yaratish uchun yer osti suvlarining shakllanishiga hissa qo‘shadigan turli jihatlarga mos keladigan turli tematik qatlamlar birlashtirilgan (3-rasm).

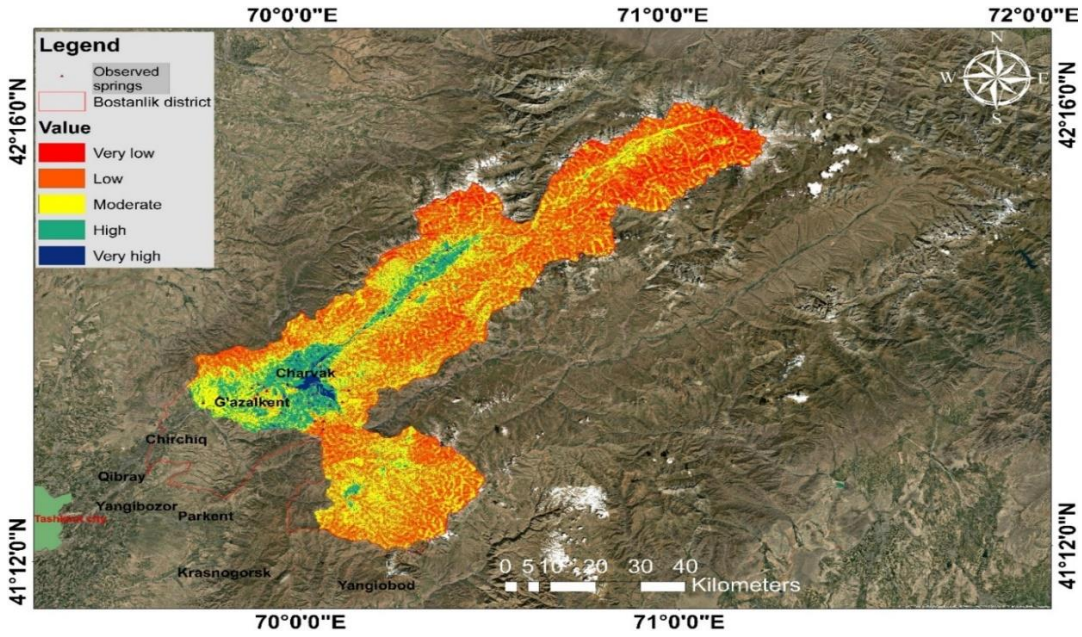


3-rasm. Yer osti suvlairing potensial zonalarini baholashda ishlatiladigan tematik qatlamlar: (a) nishablik, (b) raqamli balandlik modeli, (c) egrilik, (d) topografik namlik indeksi, (e) geologiya, (f) tuproq, (g) yer foydalanish va yer qoplami, (h) yog‘ingarchilik, (i) oqim zichligi, (j) oqimning yaqinligi

$$GPZ=\sum_{i}^{n}(Xa * Yb),$$

bu yerda X – tematik qatlamlarning og‘irligini ifodalaydi;
Y- mavzuli qatlam sinflari darajasi;
a – (a=1,2,3,……, x) tematik qatlamlar;
b –(b=1,2,3,… …, y) tematik qatlamlar sinflarini ifodalaydi.

Har bir qatlamning har bir sinfini o‘lchov shkalasi bo‘yicha 1 dan 9 gacha tartiblangan, bu yerda 1 - eng kam ustuvor qatlam (yer osti suvlarining potensial mavjudligiga eng kichik ta’sir etuvchi) va 9 - eng ko‘p ustuvor qatlam (yer osti suvlarining mavjudligiga eng yuqori ta’sir etuvchi)dan iborat. Qatlamlarning ko‘pchiligi beshta sinfga ega, chunki ular tabiiy uzilishlar yordamida qayta tasniflangan.

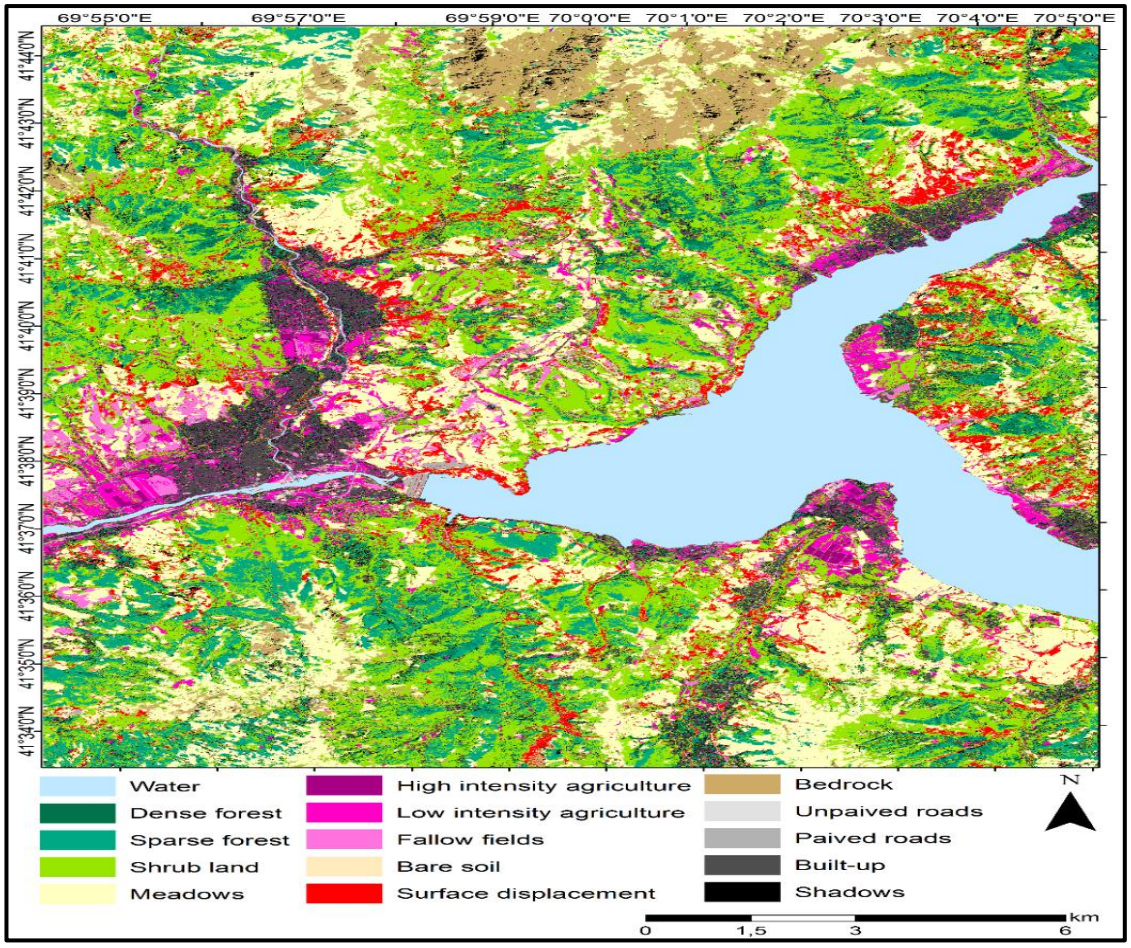


4-rasm. Tadqiqot hududida kuzatilgan yer osti suvlari potensial zonalari va buloqlar xaritasi

Yakuniy xaritada yer osti suvlarining potensial zonalari 5 ta sinfga bo‘lingan: juda pastdan juda yuqorigacha (4-rasm). Tadqiqot obyektida yer osti suvlari mavjudligining yuqori va juda yuqori ehtimoli Chorvoq suv ombori atrofida hamda Chirchiq daryosi bo‘yida sodir bo‘lishi aniqlangan. Tog‘lar bilan qoplangan hududlarda yer osti suvlari resurslari kam va juda past. Qolgan hududlar yer osti suvlari uchun o‘rtacha salohiyatga ega.

Dissertatsiyaning **“Unveiling erosion dynamics: object-based image analysis and earth observation” (Eroziya dinamikasini baholash: obyektga asoslangan tasvirni tahlil qilish)** deb nomlangan oltinchi bobida eroziya va ko‘chki jarayonlarining avtomatik tarzda xaritalash haqida ma’lumotlar qayd etilgan. Tadqiqotlar davomida Toshkent viloyati, Bo‘stonliq tumanidagi muhim obyekt bo‘lgan Chorvoq suv ombori atrofi uchun eroziya va ko‘chki jarayonlarini avtomatik tarzda aniqlash uchun OBIA usuli amalga oshirilgan. Ushbu jarayon O‘zbekiston hududida masofadan zondlash ma’lumotlaridan foydalangan holda avtomatlashtirilgan eroziya va ko‘chki inventarizatsiyasini o‘tkazish bo‘yicha birinchi urinishdir. Asosiy maqsadlarni quyidagicha umumlashtirish mumkin: tasniflash uchun GeoEye-1 dan foydalanish; OBIA ning yer qoplamining tasnifi va eroziya va ko‘chki jarayonlarining avtomatik tarzda aniqlash uchun muvofiqligini tekshirish.

Yer qoplamining tasnifi. Dala kuzatishlari asosida tuzilgan yer qoplamining tasnifi (5-rasm). Yer qoplamining 15 ta sinfi orasida o‘rganilayotgan hududda butazorlar, o‘tloqlar, suv va siyrak o‘rmonlar ustunlik qiladi va mos ravishda 28,37%, 18,22%, 11,31% va 10,47% ni tashkil qiladi (2-jadval). O‘rganilayotgan hududning 5,5 foizida ko‘chki va eroziya aniqlangan.



5-rasm. Obyektga asoslangan yer qoplami xaritasi

2- jadval

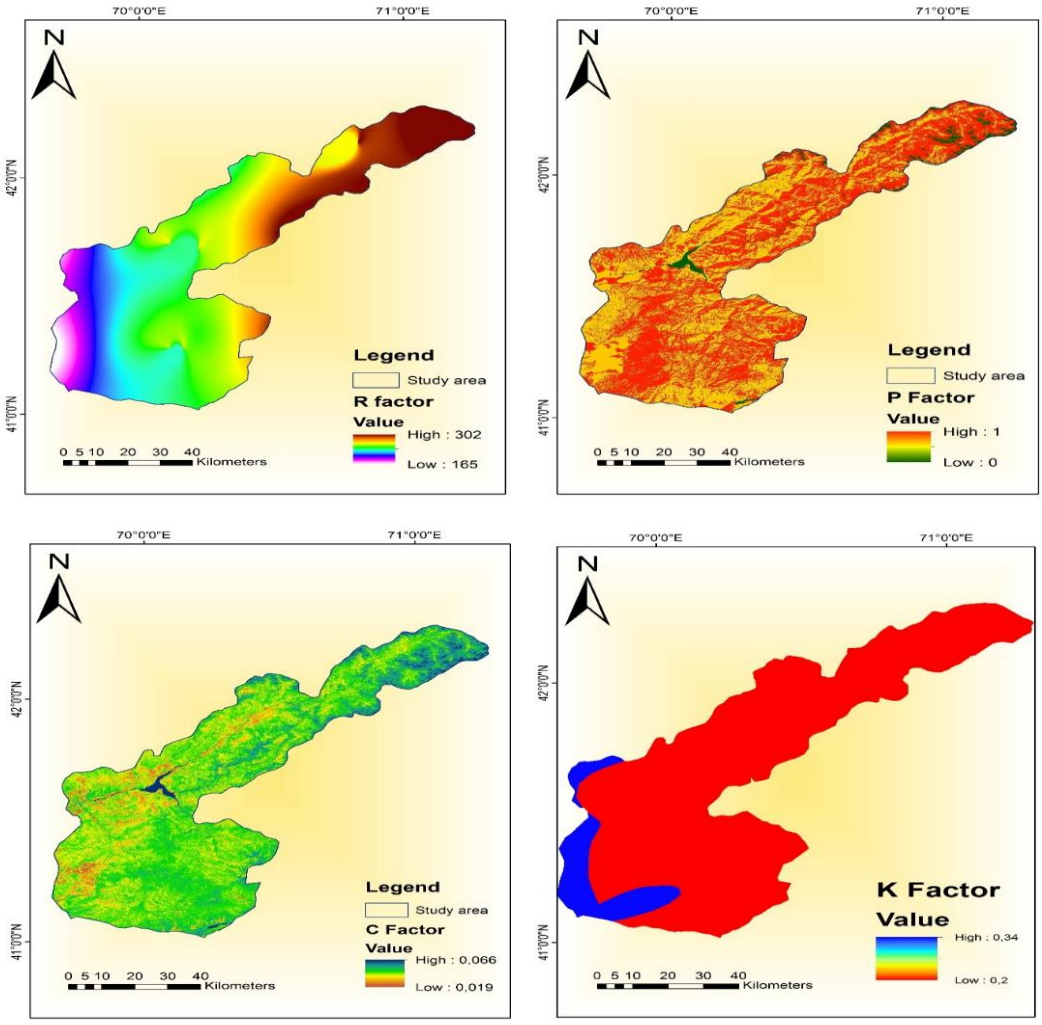
Gektar va foizlarda individual sinf qamrovi

Sinf	maydoni (ga)	maydon (%)
Eroziya va ko‘chkilar	1690.32	5.50%
Tub tog‘ jinsi	1510.04	4.91%
Ochiq tuproq	506.13	1.65%
Ekin maydonlari	445.41	1.45%
Past intensiv qishloq xo‘jaligi yerlari	1234.75	4.02%
Yuqori intensiv qishloq xo‘jaligi yerlari	182.41	0.59%
Yaylovlar	5603.02	18.22%
Butazor yer	8723.01	28.37%
Siyrak o‘rmon	3221.13	10.47%
Qalin o‘rmon	586.06	1.91%
Soyalar	1097.84	3.57%
Suv	3476.82	11.31%
Asfaltlanmagan yo‘llar	458.38	1.49%
Asfaltlangan yo‘llar	145.80	0.47%
Qurilish ostidagi yerlar	1871.39	6.09%

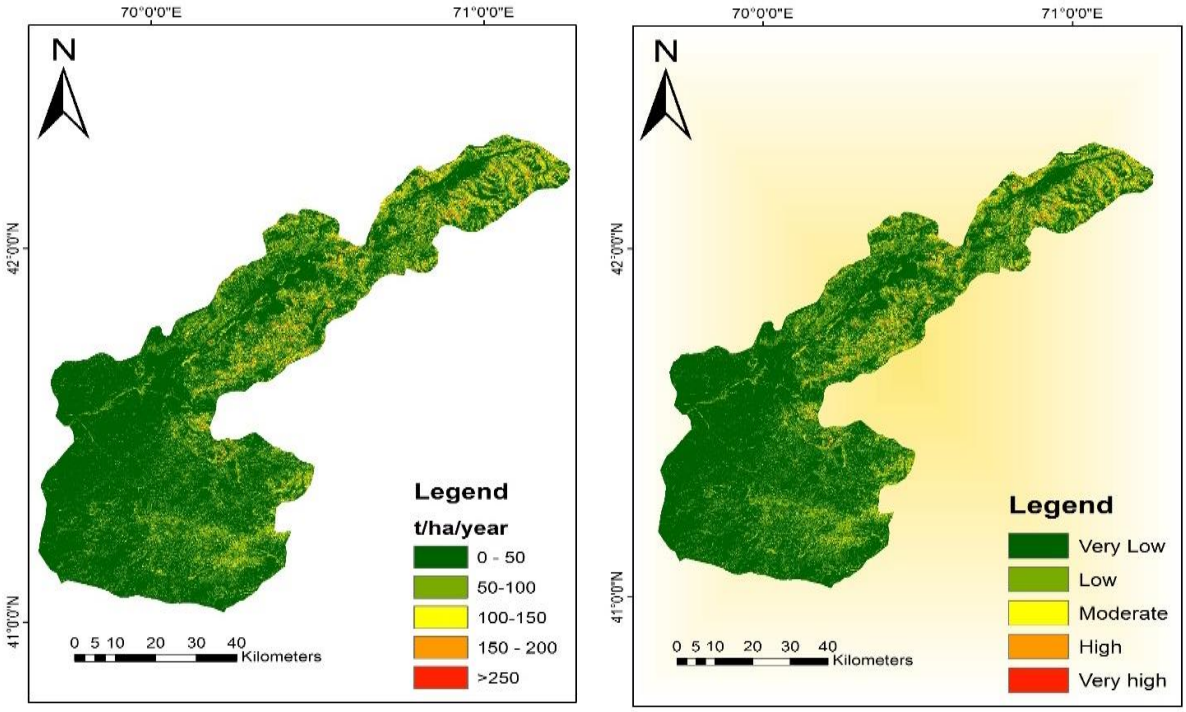
Ushbu tadqiqotda tadqiqot obyekti uchun OBIA va GeoEye-1 masofadan zondlash ma’lumotlaridan foydalangan holda birinchi avtomatlashtirilgan ko‘chki va eroziya jarayonlari xaritasi taqdim etildi. Optik sensorlar (masalan, GeoEye-1)

va OBIA usuli ko‘chki va eroziya jarayonlarini aniqlash uchun yuqori aniq natijalar berishi kuzatildi. Olingan natijadan ko‘chki va eroziya jarayonlarini batafsil inventarizatsiyasini yaratish uchun foydalanish mavjud xaritalar bilan birlashtirilishi mumkin. Natijalar uni keng miqyosda tatbiq etish va mahalliy hokimiyat organlari bilan hamkorlikda hududiy tadqiqotlar olib borish uchun ushbu idoralarga taqdim etildi.

Dissertatsiyaning “**Mapping soil erosion: integrating geospatial techniques with RUSLE in Ugam-Chatkal national park”** (Tuproq eroziyasini xaritalash: Ugom-Chotqol milliy bog‘ida geofazoviy usulni RUSLE modeli bilan birlashtirish) deb nomlangan yettinchi bobida O‘zbekistonning tog‘li hududi uchun yillik tuproq eroziya tezligini baholash uchun geofazoviy usul va RUSLE modelini qo‘llashga qaratilgan. Ushbu tadqiqot qo‘riqlanadigan tog‘li va eroziyaga juda moyil bo‘lgan Ugom-Chotqol milliy bog‘i hududida olib borildi. Tadqiqotning asosiy maqsadi yillik tuproq yo‘qotilishini baholash uchun RUSLE modeli va geofazoviy usuldan foydalanish edi. RUSLE - empirik eroziya modeli bo‘lib, u tuproq xavfi va o‘rtacha yillik yo‘qotishlarni hisoblash uchun foydali ekanligi isbotlangan. Yillik tuproq yo‘qotilishini hisoblash uchun RUSLE modeli R-factor, P-factor, K-factor, LS-factor, va C-factor kabi fizik xususiyatlar va dinamik parametrlardan foydalanadi (6-rasm).



6-rasm. RUSLE modeli uchun tematik qatlamlar



7-rasm. Ugom-Chotqol milliy bog‘ining yillik tuproq yo‘qotish xaritasi

Ushbu tadqiqot natijalariga ko‘ra, Ugom-Chotqol milliy bog‘i suv eroziyasiga moyil. Tuproq eroziyasining o‘rtacha yillik darajasi 0,00 dan 250 t ga-1 yil-1 gachani tashkil qildi. Ugom-Chotqol milliy bog‘ida hisoblangan o‘rtacha yillik tuproq yo‘qotishlari natijalarning minimal va maksimal qiymatlari bo‘yicha besh sinfga bo‘lingan. 7-rasmda har bir sinfning taqsimoti ko‘rsatilgan.

XULOSALAR

1. Scopus bazasidagi nashrlar MDH mamlakatlarida tuproq eroziyasi bo‘yicha tadqiqotlar jadal rivojlanayotganidan dalolat bermoqda. Bu mamlakatlar tadqiqotchilari tuproq eroziyasi dinamikasi va uning oqibatlarini global tushunishga faol hissa qo‘shmoqda. Tuproqni muhofaza qilishga doir tadqoqtlarda Scopus kabi bazalarning tutgan o‘rni salmoqli ekanligi tasdiqlandi va tavsiya etildi.
2. Suv sifatini saqlash, yerdan barqaror foydalanishni qo‘llab-quvvatlash va muhim yer osti suv resurslarini himoya qilish uchun har ikki jihatni hisobga olgan holda yer va suvni boshqarishning integratsiyalashgan amaliyoti zarur ekanligi aniqlandi.
3. Ugom-Chotqol milliy bog‘ining janubi-g‘arbiy qismida bo‘sh yerlar maydoni ko‘paygani kuzatilgan. Yillik yog‘ingarchilikning o‘zgarishi - asosan shimoliy hududlarda ko‘payishi va janubiy hududlarda kamayib borishi kuzatildi.
4. Tadqiqot natijalari Ugom-Chotqol milliy bog‘ining potensial yer osti suvlari zaxiralarini aniqlashda foydali bo‘lishi mumkin va metodologiyani iqtisodiy va samarali usul sifatida suv xavfsizligi va suv resurslarini boshqarish masalalarini hal qilish uchun mamlakat darajasiga ekstrapolyatsiya qilish mumkin va ko‘p

vaqtni talab qilmasligi aniqlandi va qo‘llash uchun tavsiya etildi.

5. Juda yuqori aniqlikdagi optik sensorlar (masalan, GeoEye-1) va OBIA eroziya va ko‘chki jarayonlarini aniqlash uchun juda aniq natijalar berdi. Olingan natijalar eroziya va ko‘chki jarayonlarining batafsil inventarini yaratish uchun milliy miqyosda ishlatilishi va kengaytirilishi va mavjud qo‘lda tayyorlangan xaritalar bilan birlashtirilishi mumkinligi aniqlandi.
6. Ugom-Chotqol milliy bog‘ida tuproq eroziyasining o‘rtacha yillik yo‘qotilishini baholash uchun topografik ma’lumotlar, tuproq turi, yer qoplami, yerdan foydalanish turi va yog‘ingarchilik miqdori bo‘yicha ma’lumotlardan foydalanildi, ular geofazoviy usullar asosida RUSLE modelidan foydalangan holda hisoblab chiqildi. RUSLE modelidan foydalangan holda yillik tuproq eroziyasini baholash 0,1 dan >250 t ga-1 yil-1 oralig‘ida joylashgan. Suv eroziyasining fazoviy taqsimoti RUSLE asosida GAT va masofadan zondlash yordamida samarali aniqlanadi va qo‘llash uchun tavsiya qilindi.
7. Landsat-5 TM va Landsat 8 (OLI & TIRS) sun’iy yo‘ldoshlari tasvirlarini geofazoviy tahlil asosida yaratilgan o‘simlik indeksi (NDVI), yer qoplamining o‘zgarishi (LULC) va yog‘ingarchilik ko‘rsatkichlari aks ettirilgan tematik xaritalari Chotqol hududining 5746 kv. km maydonida tarqalgan o‘simlik dunyosi va yer qoplamining holatini tahlil qilish va uni muhofaza qilishga qaratilgan chora-tadbirlarni ishlab chiqish uchun tavsiya qilindi.
8. MCDA modeli yordamida yaratilgan tematik xaritalar tadqiqot obyekti yer osti suv manbalari va tuproq eroziyasi jarayonlari o‘rtasidagi munosabatlarni aks ettiruvchi potensial yer osti suv manbalari hosil bo‘ladigan hududlarni tasniflashda foydalanish tavsiya etildi.
9. OBIA (Object-Based Image Analysis) modeli imkoniyatlaridan foydalanilgan holda yuqori aniqlikdagi GeoEye-1 sun’iy yo‘ldosh tasvirlarining geofazoviy tahlili asosida yaratilgan tadqiqot obyektining eroziya xavfi mavjud hududlari aks ettirilgan tematik xaritalar tog‘ va tog‘oldi hududlarida kechuvchi eroziya jarayonlarini avtomatik xaritalashda foydalanish tavsiya etildi.
10. RUSLE modelining asosida yaratilgan eroziya jarayonlarini keltirib chiqaruvchi omillar va ushbu jarayonlar tufayli yillik tuproq yo‘qotilishi ma’lumotlari aks ettirilgan tematik xaritalar eroziyaga uchragan tuproqlarni holatini yaxshilash bo‘yicha ekologik asoslangan tuproqni muhofaza qilish chora-tadbirlarini to‘g‘ri qo‘llash, lalmi yerlarda ekin turlarini to‘g‘ri tanlash va joylashtirishda foydalanish tavsiya etildi.

ONCE-ONLY SCIENTIFIC COUNCIL ON AWARDING SCIENTIFIC DEGREES DSc.03/27.02.2020.B.01.15 AT NATIONAL UNIVERSITY OF UZBEKISTAN

"TASHKENT INSTITUTE OF IRRIGATION AND AGRICULTURAL MECHANIZATION ENGINEERS" NATIONAL RESEARCH UNIVERSITY

JULIEV MUKHIDDIN KOMILOVICH

THEORETICAL FOUNDATIONS AND METHODOLOGY FOR MODELING EROSION PROCESSES IN MOUNTAIN AND FOOTHILL REGIONS OF UZBEKISTAN (case of Tashkent region)

11.00.05– Environmental protection and rational use of natural resources

DISSERTATION ABSTRACT OF THE DOCTORAL DISSERTATION (DSc) OF BIOLOGICAL SCIENCES

Tashkent – 2024

Subject of this dissertation for a degree of Doctor of biological sciences (DSc) has been registered under no. B2024.1.DSc/B223 by the Supreme Attestation Commission under the ministry of Higher education, science and innovation of the Republic of Uzbekistan.

The dissertation has been prepared at the "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"National Research University.

The abstract of the dissertation is posted in three languages (Uzbek, English and Russian (abstract)) on the webpages of the Scientific Council (http://nuu.uz) on the website "ZiyoNet" Information-educational portal (www.ziyonet.uz).

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The dissertation has been registered at the Information-Resource Center of the National University of Uzbekistan (Registration number No.72). Address: (100174, Tashkent city, Almazar district, Student's town, University st., 4, Phone: (+99871-246-67-72)).

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INTRODUCTION

Relevance and necessity of the dissertation topic. Today, soil degradation has become one of the main environmental problems in the world, and according to estimates, about 25% of the total land area is degraded. Around the world, 24 billion tons of fertile soil is lost due to erosion every year. By 2050, the world's population is expected to increase by 35 percent to 9.7 billion, which will increase the demand for agricultural products such as food, feed, fiber, and fuel[1]. Therefore, timely identification of degraded land, calculation of its area, stopping and prevention of the process are urgent tasks using modern technologies.

In the world, scientific research is being conducted in the direction of using modern technologies to solve problems related to soil erosion. In this regard, more effective use of new methods of remote sensing in determining, mapping, monitoring and modeling of soil erosion, geoecological assessment of lands with erosion risk in mountain and foothill regions using satellite images, and the use of geoinformation systems are aimed at special attention is paid to the implementation of scientific research.

A number of scientific studies on the monitoring of protected natural areas, including national parks, are being carried out in the republic in the last years, and certain results are being achieved in this regard. Decree of the Cabinet of Ministers of the Republic of Uzbekistan dated 11.06.2019 No. 484 "On approval of the strategy for the preservation of biological diversity in the Republic of Uzbekistan for the period 2019-2028"[2]…creation of a single centralized monitoring system for biodiversity components in reference ecosystems and creation of an information database for state monitoring of negative effects on these components due to soil degradation based on modern geoinformation technologies (GIS technologies)" is defined as one of the important strategic tasks. In this regard, it is important to create a cartographic database of territories using remote sensing and GIS technologies of degraded lands, various modeling methods, constantly update it, adapt to climate change and prepare soil erosion forecasting maps, as well as create measures to prevent land degradation.

This dissertation research to a certain extent serves to fulfill the tasks stipulated in the Decree of the President of the Republic of Uzbekistan dated May 31, 2017 PD-5065 "On measures to strengthen control over the protection and rational use of land, improve geodetic and cartographic activities, streamline the maintenance of state cadastres", the Decree of the President of the Republic of Uzbekistan dated September 11, 2023 PD-158 "On the strategy “Uzbekistan-2030””, Decree of the Cabinet of Ministers of the Republic of Uzbekistan dated July 19, 2017 No. 530 "On measures to further improve the forestry management system", as well as in other legal documents adopted in this area.

This dissertation serves to a certain extent in the implementation of the tasks specified in the Decree of the President of the Republic of Uzbekistan dated May

[1]https://www.thegef.org/what-we-do/topics/land-degradation

[2]Decree of the Cabinet of Ministers of the Republic of Uzbekistan dated 11.06.2019 No. 484 "On approval of the strategy for the preservation of biological diversity in the Republic of Uzbekistan for the period 2019-2028"

31, 2017 No. PF-5065 "On measures to strengthen control over land protection and rational use, improvement of geodesy and cartography activities, regulation of state cadastre maintenance"[3], Decree of the President of the Republic of Uzbekistan dated June 17, 2019 No. PF-5742 "On measures for effective use of land and water resources in agriculture"[4], Decree of the President of the Republic of Uzbekistan dated June 10, 2022 Resolution No. PQ-277 "On measures to create an effective system of combating land degradation"[5], Decree of the President of the Republic of Uzbekistan dated September 11, 2023 No. PF-158 “On the Strategy "Uzbekistan - 2030"[6] and other regulatory legal documents related to this activity.

Correspondence of the research with the priorities of the development of science and technology of the republic. This research was carried out within the framework of the III. "Development of information and information and communication technologies" and V. "Agriculture, biotechnology, ecology and environmental protection" priorities of the republic’s science and technology development.

Review of foreign research on the topic of the dissertation[7].

Scientific research aimed at the introduction of modern information technologies in the assessment of erosion processes is carried out by the world's leading scientific centers and higher education institutions, including Georg-August-Universität Göttingen (Germany), Università Ca' Foscari Venezia, Department of Environmental Sciences, Informatics and Statistics (Venice), Southern Illinois University Carbondale (USA), National Research Center Egypt (Egypt), University of Agriculture in Krakow, Department of Land Reclamation and Environmental Development (Poland), Technical University of Denmark (Denmark), Natural Resources Management and Sustainable Development (England), as well as Dimo Moldova Institute of Soil Science, Agrochemistry and Soil Protection (Moldova), Dokuchaev Institute of Soil Science (Russia), Moscow State University named after Lomonosov, Russian State Agrarian University named after Timiryazev, Uspanov Institute of Soil Science and Agrochemistry (Kazakhstan), Research Institute of Soil Science and Agrochemistry (Uzbekistan).

As a result of world research on remote sensing of erosion processes in mountain soils and the use of geoinformation systems, a number of scientific results have been obtained, including the following: it has been proven that soil cover classification can be clarified using remote sensing methods of soil maps (Southern Illinois University Carbondale); the importance of GIS technologies was considered in the process of creating maps describing the relief of mountain areas (National

[3]Decree of the President of the Republic of Uzbekistan dated May 31, 2017 No. PF-5065 "On measures to strengthen control over land protection and rational use, improvement of geodesy and cartography activities, regulation of state cadastre maintenance".
[4]Decree of the President of the Republic of Uzbekistan dated June 17, 2019 No. PF-5742 "On measures for effective use of land and water resources in agriculture".
[5]Decree of the President of the Republic of Uzbekistan dated June 10, 2022 Resolution No. PQ-277 "On measures to create an effective system of combating land degradation".
[6]Decree of the President of the Republic of Uzbekistan dated September 11, 2023 No. PF-158 “On the Strategy "Uzbekistan - 2030".
[7]Review of scientific research on the topic of the dissertation developed on the basis of http://www.works.doklad.ru, http://www.km.ru, www.dissercat.com, researchget.net, http://www.fundamental-research.ru, www.webofscience.com and other sources.

Research Center Egypt); It has been determined that erosion processes in mountainous and mountainous areas depend on the characteristics of the layers created on the basis of the digital model of the relief (Natural Resources Management and Sustainable Development); remote sensing and GIS technologies have been proven to be important in determining degradation types in soil erosion studies (Moldova Institute of Soil Science, Agrochemistry and Soil Protection named after N. Dimo).

Today, in the world, a number of researches are being carried out on the evaluation of transient erosion processes in soils distributed in mountain and sub-mountain areas using GIS technologies and remote sensing methods, including the following priority directions: the use of various models in the assessment and prediction of soil erosion and adaptation of models to climate change conditions; creation of a database of maps that includes various factors in determining the risk of soil erosion; improving methods of using high-resolution remote sensing images in monitoring and mapping erosion processes.

Level of study of the problem. For many years, classical erosion scientists in the world have collected a lot of information on the laws of the origin of erosion processes, including the factors that cause erosion, the impact of erosion processes on the properties of soils, soil protection measures to restore soil fertility of eroded soils. Among them we can cite the works B.Pradhan, A.Arabameri, M. Zaslavsikiy, G. Surmach, G. Shvebs, V. Hussak, M. Kuznetsov, M. Doshchanov, F. Kocherga, A. Khanazarov, S. Elyubaev, Kh. Maksudov, L. Gafurova, G. Djalilova and others. However, for the purpose of nature protection, the scientific research on the implementation of geospatial analysis of erosion processes and soil erosion modeling methods in uneven mountain and mountainous regions, their improvement, that is, the introduction of modern approaches based on the integration of surface data with remote sensing data, has not been carried out sufficiently.

The relation of the dissertation research with the research plans of the university in which the dissertation was completed. Dissertation research has been completed in connection with projects: MUNIS/CS/CQS/6 "Modernizing Uzbekistan National Innovation System (MUNIS) project (2022-2023), 609574-EPP-1-2019-1-IT-EPPKA2-CBHE-JP - "Environmental protection of cultural heritage assets in Central Asia risk assessment and reduction" (2020-2024) projects and scientific research plans of the "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University "Ecology and Water Resources Management" Department and National University of Uzbekistan Department of Biology "Soil Science" department.

Aim of the research. Evaluation of erosion processes in the mountain and foothill areas based on geo-information technologies and remote sensing methods and improvement of modeling methods of soil erosion processes.

Research objectives:

based on the experience of the CIS countries, to analyze the works on the subject and, according to them, to develop a strategy of geospatial analysis in

determining, evaluating and creating models of erosion processes in mountain and sub-mountain areas;

to apply the RUSLE model, analyze the natural and climatic conditions of the area in order to adapt the natural factors that cause erosion processes to the model;

geospatial analysis based on the calculation of various indices of periodic satellite images for the purpose of monitoring data on vegetation and land cover of the research object depending on the conditions of climate change;

geospatial analysis of primary cartographic, hydrometeorological, regionally distributed groundwater information and satellite images as a basis for the application of the MCDA model;

selection of high-resolution satellite images of the research object as a basis for the application of the OBIA (Object-Based Image Analysis) model, and creation of thematic maps of zones with erosion risk through geospatial analysis.

creation of thematic maps with data on annual soil loss due to erosion processes based on the RUSLE model adapted to the research object.

Study area soil and vegetation cover, groundwater and soils with erosion risk in the mountainous and foothill area of the Ugam-Chatkal National Park.

Subject of study soils of mountainous and foothill area, dynamics of land cover changes, the relationship between groundwater and the erosion process, various thematic maps, mapping and modeling of erosion processes.

Research methods. Field and laboratory studies were carried out according to generally accepted methods. Scientific studies were carried out using remote sensing methods and GIS technology. In particular, the object of research is the relationship between groundwater resources and soil erosion processes MCDA (Multi-Criteria Decision Analysis) model, geospatial analysis of satellite images OBIA (Object-Based Image Analysis) model, annual soil loss as a result of erosion processes loss was performed using the RUSLE model, while vegetation index (NDVI) and land cover change (LULC) indices were calculated. Remote sensing data was processed using QGIS, Google Earth, Google Earth Engine, ArcGIS and other programs.

The scientific novelty of the research is as follows:

for the first time, a bibliometric database was created on the basis of the scientific and bibliometric database on soil erosion in the CIS countries during the last 60 years, and a strategy of geospatial analysis was developed to identify, evaluate and model erosion processes in mountain and foothill areas;

in the Ugam-Chatkal National Park, under conditions of climate change, it has been established that the geospatial use of satellite images based on calculations of plant indices provides high-precision data in determining changes in the flora and vegetation cover of the territory over a 20-year period;

for the first time, the advantages and capabilities of the MCDA model for multi-criteria decision analysis in determining the relationship between groundwater sources and soil erosion processes have been improved in order to carry out a geospatial analysis of erosion processes in the research object and to approve the models;

for the first time, the method of automatic detection of erosion processes through high-resolution satellite images and the OBIA (Object-Based Image Analysis) model was applied at the research area, and its capabilities were evaluated;

in order to model erosion processes using the RUSLE model based on geospatial analysis, the parameters of the RUSLE model were adjusted and its capabilities were improved, taking into account the specific characteristics of the research area.

The practical results of the study are as follows:

a basis for modeling erosion processes was created using the strategy for identifying, evaluating and modeling erosion processes in mountain and foothill areas developed;

on the basis of geospatial analysis, satellite image processing, i.e. vegetation index (NDVI), land cover change (LULC) and precipitation indicators were calculated and thematic maps were developed;

with the help of the MCDA model, thematic maps reflecting the relationship between the research object groundwater sources and soil erosion processes were created, and based on them, the areas where potential groundwater sources are formed were classified;

using the OBIA (Object-Based Image Analysis) model with the possibility of automatic mapping, through the geospatial analysis of high-resolution satellite images of the research object, erosion risk areas were separated and thematic maps were created;

taking into account the natural climatic conditions, the factors that cause erosion processes, which are the basis of the RUSLE model, were adjusted according to this data, and based on them, thematic maps were created that reflected the data of annual soil loss as a result of erosion processes.

Reliability of the results of the study. The reliability of the research results is based on generally accepted research methods and confirmation of the obtained theoretical results with practical data, comparing the research results with the results of other authors in a similar direction, and applying the research results to practice. Almost all results have been published in prestigious publications.

Scientific and practical significance of the research results. The scientific significance of the research results is explained by the integration of the methods of remote sensing and geospatial analysis, using the capabilities of various models in the monitoring of the erosion processes in the studied area, and providing accurate information in the identification, assessment and creation of models of the erosion processes in the mountainous regions.

The practical importance of the research results is determined by the fact that the created thematic maps serve in the development of a number of based ecological measures to improve the condition of the eroded areas, in the analysis of the state of the flora and in the development of measures aimed at its protection.

Implementation of the research results. Based on the results of the research, theoretical foundations and methodology for modeling erosion processes in mountain and foothill regions of Uzbekistan:

Based on the Scopus database, a database of articles published in English on the topic of soil erosion and a method of statistical analysis was formed. This database was put into practice through the "English for Science" program, which is being implemented within the implementation group of the "Modernization of the National Innovation System of Uzbekistan" project (reference of the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan). As a result, this bibliometric database develops a research methodology by studying the world experience of young researchers in the field of environmental protection and rational use of natural resources in the field of identification, assessment, modeling of erosion processes and the development of soil protection measures against these processes.

Thematic maps created using the MCDA (Multi-Criteria Decision Analysis) model have been put into practice. The results of the dissertation were implemented in the practice of the state institution "Institute of Hydrogeology and Engineering Geology" within the University of Geological Sciences (Reference No. 08-4522 of the Ministry of Mining and Geology of the Republic of Uzbekistan dated December 12, 2023). As a result, the research object made it possible to classify the areas where potential underground water sources are formed, reflecting the relationship between underground water sources and soil erosion processes.

Using the capabilities of the OBIA (Object-Based Image Analysis) model, thematic maps showing the erosion risk areas of the research object, created on the basis of geospatial analysis of high-resolution GeoEye-1 satellite images, have been put into practice. The results of the dissertation were implemented in the practice of the state institution "Institute of Hydrogeology and Engineering Geology" within the University of Geological Sciences (Reference No. 08-4522 of the Ministry of Mining and Geology of the Republic of Uzbekistan dated December 12, 2023). As a result, this development made it possible to automatically map erosion processes in mountain and sub-mountain areas.

Based on the RUSLE model, thematic maps showing factors causing erosion processes and annual soil loss due to these processes have been put into practice of the Research Institute of Environmental and Nature Protection Technologies within the Ministry of Climate Change (Reference No. 03-03/3-7523 dated November 29, 2023 of the Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan). As a result, the correct application of ecologically based soil protection measures to improve the condition of eroded soils, and the correct selection and placement of crop types in drylands served.

Landsat-5 TM and Landsat 8 (OLI & TIRS) satellite images, created on the basis of geospatial analysis, have been put into practice of the Research Institute of Environmental and Nature Protection Technologies within the Ministry of Climate Change (Reference No. 03-03/3-7523 dated November 29, 2023 of the Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan). As a result, these thematic maps served to analyze the condition of flora and land cover spread over 575 thousand hectares of Ugam-Chatkal region and to develop measures aimed at its protection.

Approbation of the research results. The results of the study were discussed at 4 international and 2 republican scientific and practical conferences.

Publication of research results. A total of 22 scientific papers were published on the subject of the dissertation, of which 7 papers were published in Scopus and Web of Science database and 11 in national journals, in which the main scientific results of doctoral dissertations of the Higher Attestation Commission of the Republic of Uzbekistan were recommended for publication.

Dissertation structure and volume. The dissertation consists of an introduction, 7 chapters, a conclusion, an appendix and a list of used literature. The total volume of the dissertation is 172 pages.

THE MAIN CONTENT OF THE DISSERTATION

In the **introduction** part, the necessity and relevance of the ongoing research in Uzbekistan and the world are substantiated, the goal and objectives, objects and subjects of work, compliance with priority areas for the development of science and technology in Uzbekistan are formed. The scientific novelty and practical results of the research are shown. The theoretical and practical significance of the results obtained is substantiated, information is given on the approval of the work and the implementation of the results, the volume and structure of the dissertation.

I chapter of the dissertation named **«Analyzing soil erosion trends in CIS countries through scopus database»** shows based on research goals and tasks, a bibliometric analysis of articles published on the topic of soil erosion in the Scopus database for 61 years. This chapter covers the processes and causes of erosion (research often examines the factors that lead to soil erosion, including agricultural practices, climate change, land use, and changing topography); erosion modeling (researchers develop various models and simulations to predict soil erosion and identify vulnerable areas); erosion monitoring and assessment (using methods and tools used to monitor soil erosion such as remote sensing, GIS and field measurements); soil conservation and mitigation of degradation processes (consideration of erosion control measures); impacts on agriculture and water resources (discussing the impact of soil erosion on crop yields and water quality, introducing sustainable land management practices); international cooperation in solving the problem, challenges in solving the problem, and attention to future directions are given. The following conclusions can be drawn from this chapter: introduction of integrated approaches (interdisciplinary research combining soil science, hydrology, agronomy and climate science is necessary for a holistic understanding of soil erosion dynamics); capacity building (training and capacity building initiatives to increase the knowledge of researchers and practitioners in soil erosion management); climate change adaptation (as climate change intensifies, research examines the interaction between climate change and soil erosion, identifying adaptation and resilience strategies);

II and III chapter named **“Physical and geographical conditions of Ugam-Chatkal national park” and “Interaction of soil erosion with groundwater and**

climate change issues" dedicated to the problems of soil erosion in Uzbekistan, the driving factors and the connection of soil erosion with climate change and groundwater activity. This chapter analyzes several aspects of soil erosion interactions. Brief analysis of soil erosion problems in Uzbekistan, types of soil erosion, factors causing soil erosion are presented. The research object is formed from loess-like bedrock, and as the height above the sea level increases, it was observed that the thickness of loess-like rocks decreases, and they are classified as proluvial, deluvial-proluvial deposits. The natural conditions of the research site are one of the main factors affecting the rapid progress of erosion processes. causes diversity and disturbance of ecological balance. Thus, it is explained by the strong slope of the slopes formed in a number of uneven relief conditions, the exposure, the destabilization of the slopes due to the washing and erosion of the soil due to the precipitation that falls in the spring and autumn-winter seasons, weakens their structural integrity, and increases the probability of catastrophic events that threaten the natural and human environment. The climatic conditions of the research object have specific characteristics, with the increase in height above the sea level, the air temperature is slightly lower, and the types of vegetation and soil change depending on the increase in the amount of precipitation.

IV chapter named **"Transforming landscapes: land use and cover change analysis in ugam-chatkal national park"** shows the results of the analysis obtained during the process of determining the changes of the soil and vegetation cover of the Ugom-Chotkal National Park in 20 years according to several criteria are presented. Landsat-5 TM and Landsat 8 (OLI & TIRS) satellite images were downloaded in June using the Earth explorer platform (Table 1, Fig.1). Landsat satellite imagery has eight 30m reflectance bands, one 15m panchromatic and two 100m thermal bands with a resolution of 30x30m.

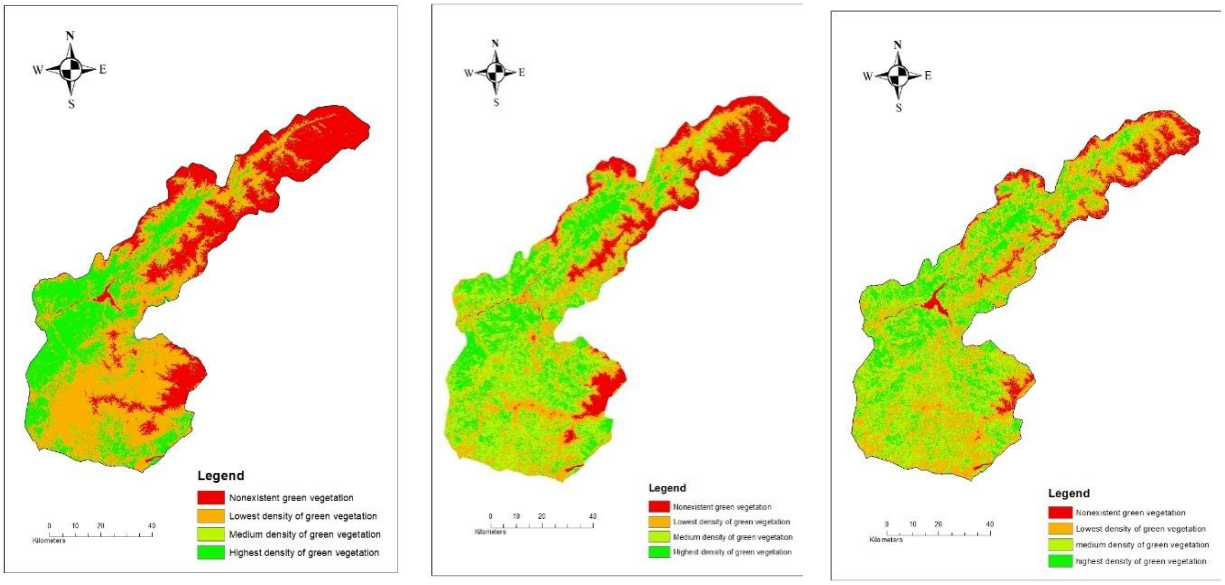
Table 1.

Results of LULC assessment in the Ugam-Chatkal national Park

Classes	Area (km square)		
	2000	2010	2020
Snow	3200.3	1513.96	587.019
Bare land	1686.68	2239.74	2273.74
Water	54.3852	73.8441	45.8622
Vegetation	1684.19	2798	3741.37

The impact of global climate change in the Central Asian region is escalating each year, underscoring the growing importance of Remote Sensing (RS) and Geographic Information Systems (GIS) systems in analyzing these dynamics. During the research period, a decline in snow cover has been observed across the national park. Anthropogenic influences have led to an expansion of bare lands in

the southwestern areas of the park. Changes in annual precipitation patterns have been observed, with increases predominantly noted in the northern region and decreases in the southern regions.



a) 2000 b) 2010 c) 2020

Figure 1: NDVI map of Tashkent region

V chapter named **"Evaluating groundwater potential: precision of geospatial data in multi-criteria decision analysis".** The expensive, time and labor-intensive traditional methods often used in the mapping of underground water resources, including hydrological, geological, geophysical and geomorphological tools of the research object, approaches that create wide opportunities in the implementation of this work - remote sensing for the analysis of potential zones of groundwater and tt is noted that the GIS technique can be used. Studies have observed that although satellite images do not directly indicate groundwater areas, remote sensing analysis products can be used for further multi-criteria analysis of groundwater availability. In carrying out this process, the study aimed to investigate the accuracy of the multi-criteria decision analysis tool used to determine the location of existing springs and groundwater potential zones using geospatial techniques. General groundwater thematic layers are prepared to determine the presence of aquifers, namely Digital Elevation Model (DEM), Slope, Soil Map, Geological Map, Land Use/Land Cover (LULC), Stream Proximity, Stream Density, Curvature, Topographic Moisture Index (TWI) and precipitation from underlying satellite data and other primary sources were processed as critical layers for the multi-criteria decision analysis tool in ArcGIS and ERDAS Imagine (Figure 2).

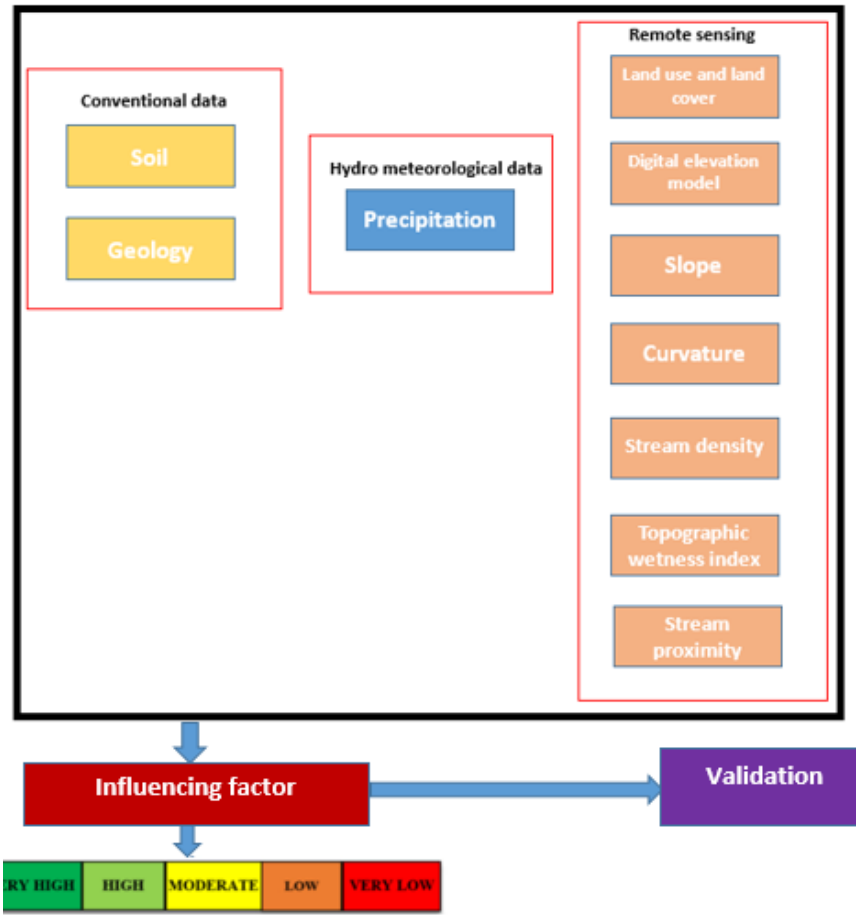


Figure 2. Flowchart of the methodology for groundwater potential mapping

A multi-criteria decision analysis tool, particularly the influence factor method, is widely used to delineate groundwater potential zones in GIS. The MCDA tool was developed by Saati and helps to combine all thematic layers according to their weight value. During the research, different thematic layers corresponding to different aspects contributing to the formation of groundwater were combined to create the final map using the following formula (Figure 3).

$$GPZ=\sum_{i}^{n}(Xa * Yb),$$

where X - represents the weight of the thematic layers; Y - represents the rank of the thematic layer' classes, then the term a – (a=1,2,3,……, x) shows the thematic layers and the term b – (b=1,2,3,……, y) represents classes of the thematic layers.

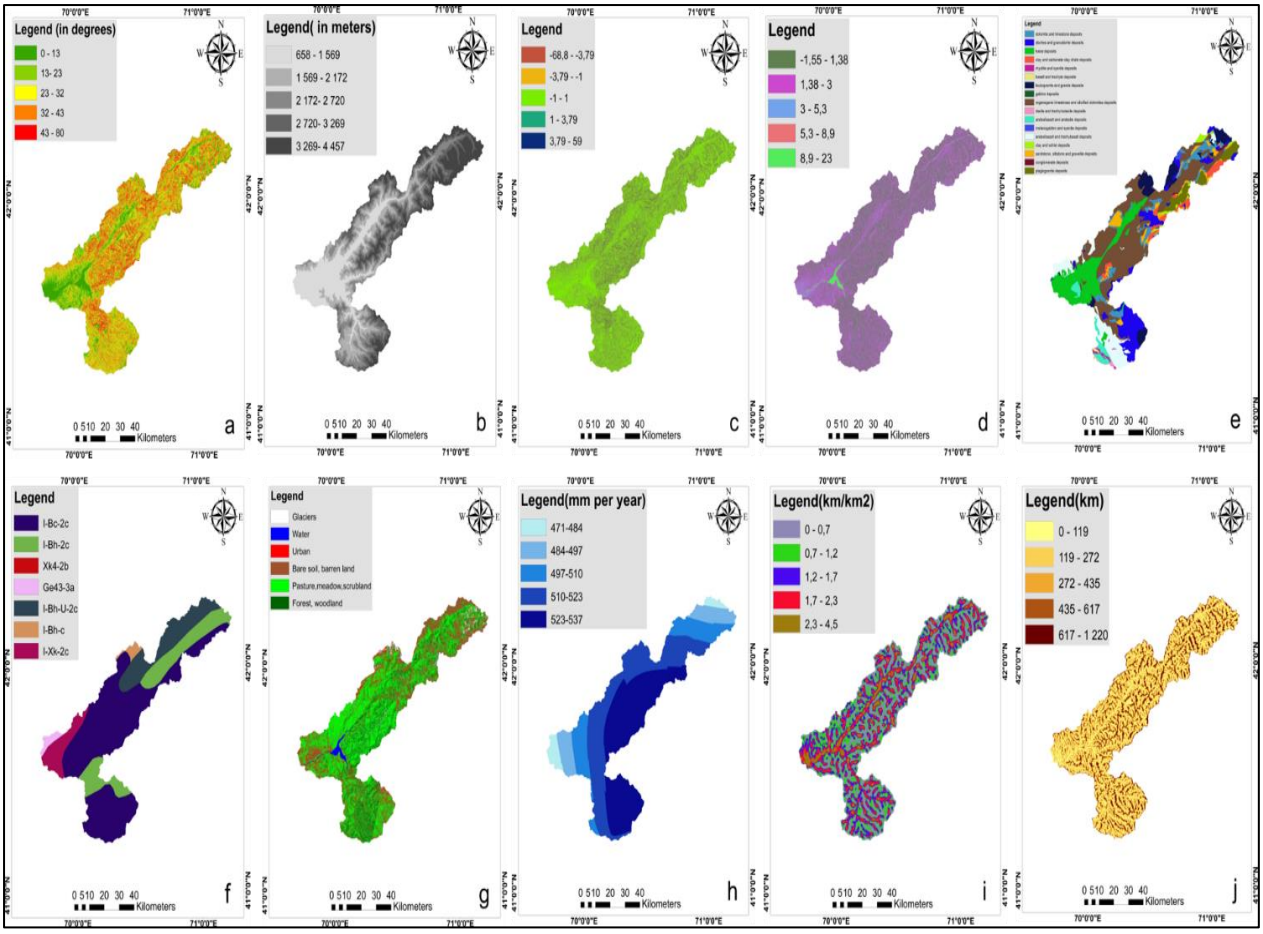


Figure 3. Thematic layers used for groundwater potential zones assessment: (a) slope, (b) digital elevation model, (c) curvature, (d) topographic wetness index, (e) geology, (f) soil, (g) land use and land cover, (h) precipitation, (i) stream density, (j) stream proximity

We ranked each class of each layer from 1 to 9 according to Saaty's measurement scale, where 1 is the least priority layer (has the smallest impact on groundwater potential existence), and 9 is the highest impact on groundwater existence. Most of the layers have five classes, because they were reclassified using natural breaks and then reclassified from continuous to discrete dataset.

The final map shows the likelihood of incidence of groundwater in 5 ordinal scales: from very low to very high (Fig. 4). High and very high probabilities of groundwater existence occur within or across the Charvak reservoir and along the Chirchik River. Territories, covered by the mountains have low and very low probablity of groundwater resources. The rest of the teritory has a moderate potential for groundwater resources.

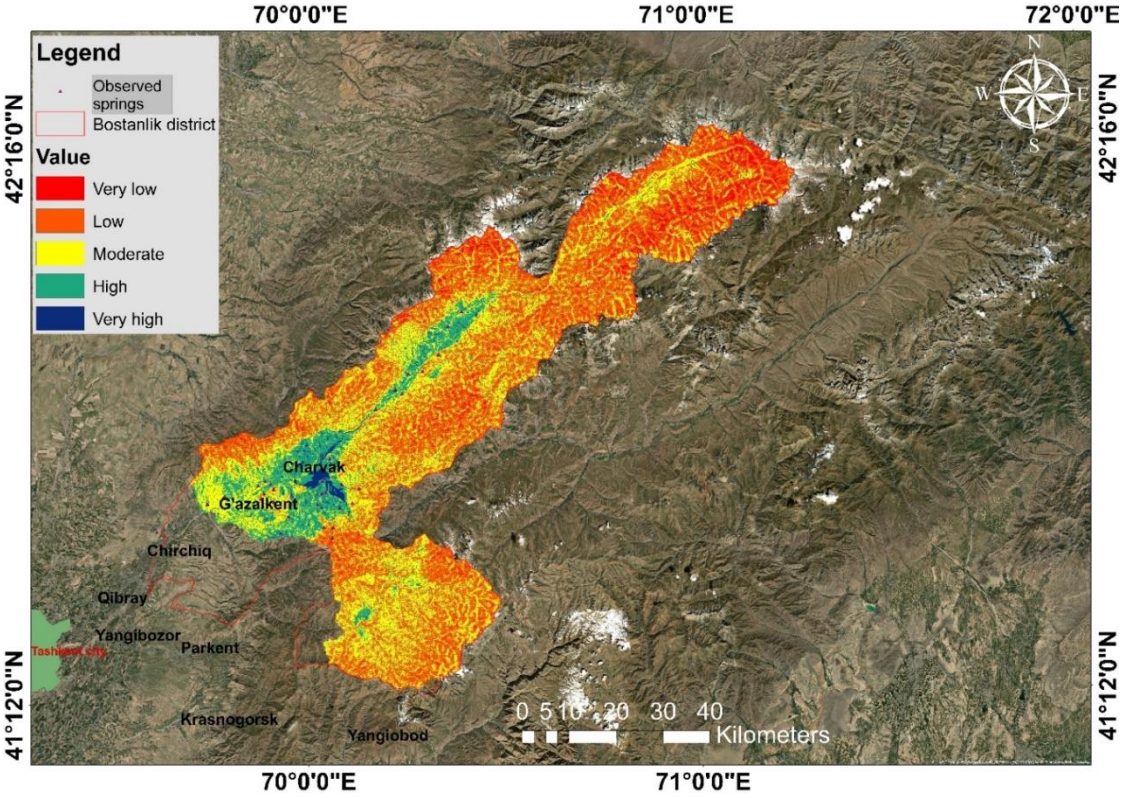


Figure 4. Map of groundwater potential zones and springs observed in the study area

VI chapter named **"Unveiling erosion dynamics: object-based image analysis and earth observation"** mainly devoted to the application of GIS technologies to automatic mapping of erosion and sliding processes in mountainous regions. The main scope of the present study is to perform OBIA for surface displacement detection for the surround area of the Charvak Reservoir, an important site in the Bostanlik district, Tashkent region, Uzbekistan. This work is the first attempt of performing an automated surface displacement or erosion and sliding s inventory using EO data within the territory of Uzbekistan. The main objectives can be summarized as following: utilizing GeoEye1 for the classification; verifying the suitability of OBIA for the land cover classification and surface displacement; obtaining detailed surface displacement areas for the study area for further utilizing them for erosion and sliding s susceptibility and risk mapping.

Land cover classification. The land cover classification (Figure 5) generated based on field observations. Among the 15 land cover classes shrub land, meadows, water, and sparse forest are dominant within the study area representing 28.37%, 18.22%, 11.31%, and 10.47% respectively (Table 2). Erosion and sliding s were detected on 5,5% of the study area.

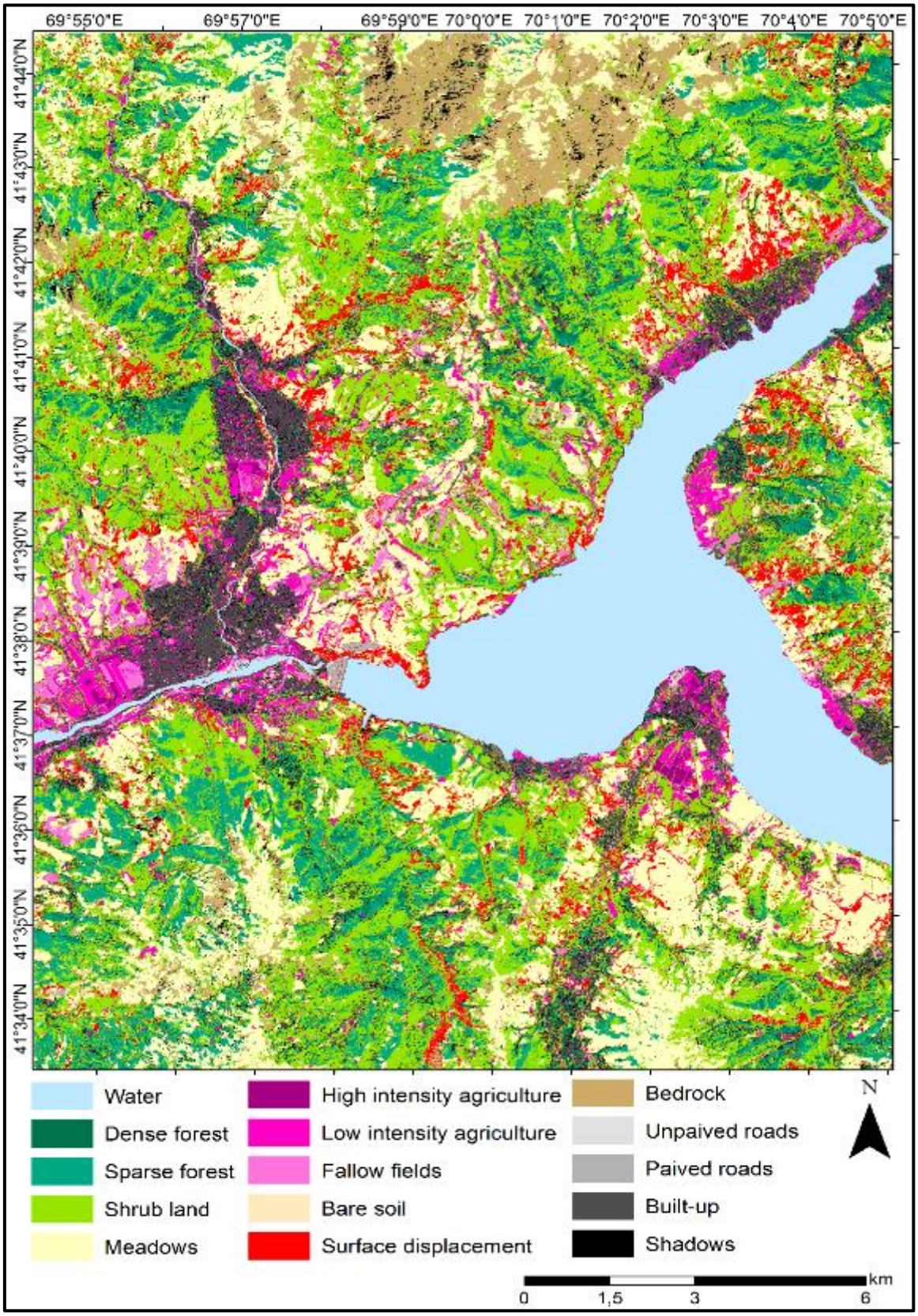


Figure 5. Land cover map of the object-based random forest classification

Table 2.

Individual class coverage in hectare and percentages

Class	Area (ha)	Area (%)
Surface displacement	1690.32	5.50%
Bedrock	1510.04	4.91%
Bare soil	506.13	1.65%
Fallow fields	445.41	1.45%
Low intensity agriculture (LIA)	1234.75	4.02%
High intensity agriculture (HIA)	182.41	0.59%
Meadows	5603.02	18.22%
Shrub land	8723.01	28.37%
Sparse forest	3221.13	10.47%
Dense forest	586.06	1.91%
Shadows	1097.84	3.57%
Water	3476.82	11.31%
Unpaved roads	458.38	1.49%
Paved roads	145.80	0.47%
Built-up	1871.39	6.09%

In this study, we present the first automated surface displacement map using OBIA and VHR GeoEye1 EO data for the Bostanlik district, Uzbekistan. We conclude VHR optical sensors (i.e. GeoEye-1) and OBIA are providing highly accurate results for detecting erosion and sliding s. The obtained result can be used and up scaled to a national level to create a detailed erosion and sliding inventory and can be combined with the existing manual maps. The results presented to these agencies for its large-scale implementation and regional research conducted with the cooperation of the local authorities.

VII chapter named **"Mapping soil erosion: integrating geospatial techniques with RUSLE in Ugam-Chatkal national park"** aims to use geospatial techniques and RUSLE model to estimate the annual soil erosion rate for the mountainous region of Uzbekistan. This study was conducted in the Ugam-Chatkal national park, a protected mountainous and highly erosion-prone area. The main objective of the study was to use the RUSLE model and geospatial techniques to estimate annual soil loss. RUSLE is a model for empirical erosion that has been proven to be useful for calculating the risk and average yearly soil losses. For the purpose of calculating the annual soil loss, the RUSLE model uses physical characteristics and surface dynamic changes like the R-factor, P-factor, K-factor, LS-factor, and C-factor (Figure 6).

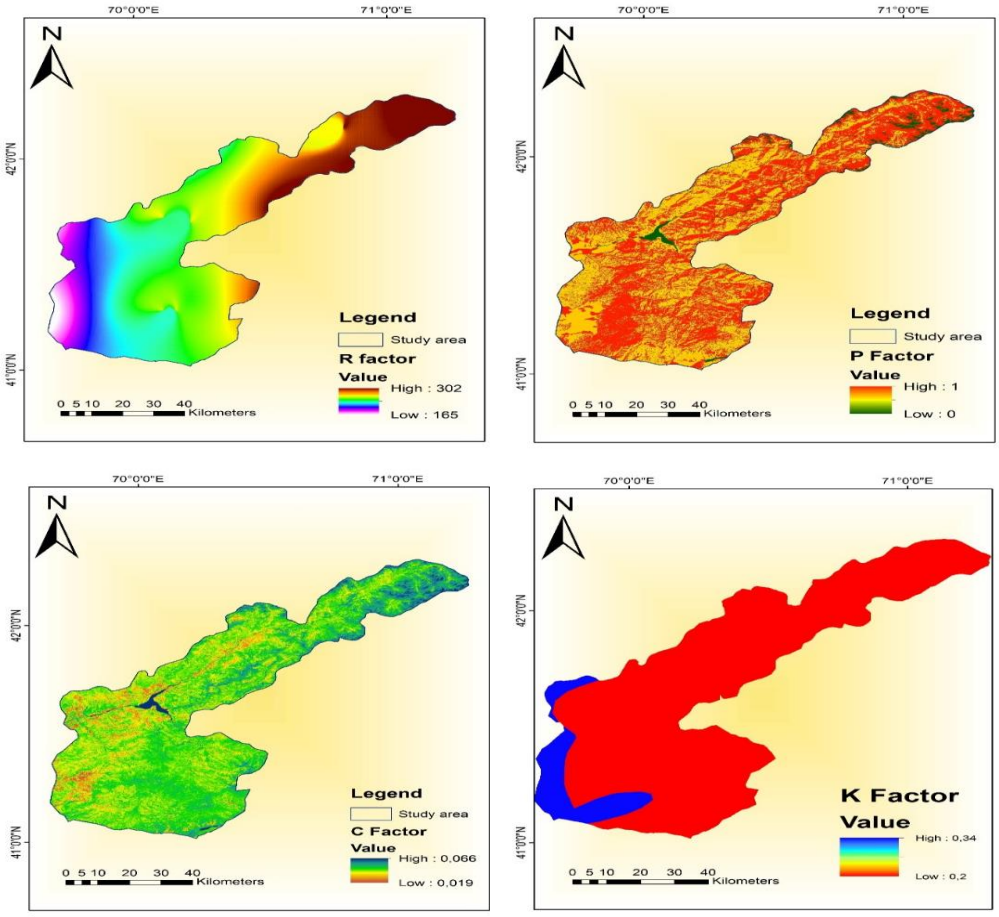


Figure 6. Thematic layers for RUSLE model

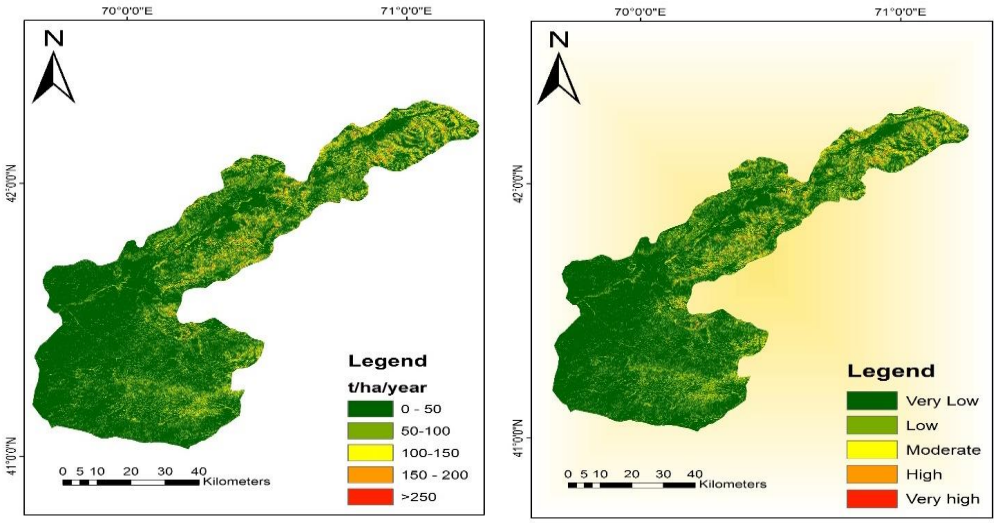


Figure 7. Annual soil loss map of Ugam-Chatkal national park

Assessment of the erosion potential in the Ugam-Chatkal national park. According to the findings of this research, Ugam-Chatkal national park is prone to water erosion. The average annual rate of soil erosion ranges from 0.00 to 250 t ha-1 year-1. The calculated average annual soil losses in Ugam-Chatkal national park were divided into five classes based on the minimum and maximum values of the results. Figure 8 shows the spatial distribution of each class.

CONCLUSIONS

1. Publications in the Scopus database indicate that research on soil erosion in the CIS countries is developing rapidly. Researchers from these countries actively contribute to the global understanding of the dynamics of soil erosion and its consequences. The important role of databases such as Scopus in soil protection studies was confirmed and recommended.
2. It was found that integrated land and water management practices considering both aspects are necessary to maintain water quality, support sustainable land use, and protect important groundwater resources.
3. The area of open land has increased in the southwestern part of the Ugam-Chatkal national park. The change of annual precipitation was observed - it increased mainly in the northern regions and decreased in the southern regions.
4. The results of the research can be useful in determining the potential underground water reserves of the Ugam-Chatkal National Park, and the methodology can be extrapolated to the country level to solve the issues of water security and water resources management as an economical and effective method and it was found that it does not require a lot of time and is recommended for use.
5. Very high-resolution optical sensors (for example, GeoEye-11) and OBIA gave very accurate results for determining erosion and landslide processes. It was found that the results obtained can be used and scaled up to the national level to create a detailed inventory of erosion and landslide processes and integrated with existing manual maps.
6. In order to estimate the average annual rate of soil erosion in the Ugam-Chatkal national park, topographic data, data on soil type, land cover, land use type, and precipitation amount were used and calculated using the RUSLE model. Results show that annual soil erosion estimates using the RUSLE model range from 0.1 to >250 t ha-1 yr-1. Spatial distribution of water erosion based on RUSLE is effectively determined using GIS and remote sensing and recommended for use.
7. Geospatial analysis of Landsat-5 TM and Landsat 8 (OLI & TIRS) satellite images showing vegetation index (NDVI), land cover change (LULC) and precipitation indicators thematic maps were recommended to analyze the condition of flora and land cover distributed in the Chotkal area with the territory of 5746 sq. km and to develop measures aimed at its protection.
8. Thematic maps created using the MCDA model were recommended to be used in the classification of areas where potential underground water sources are formed, reflecting the relationship between the groundwater sources of the research object and soil erosion processes.
9. Using the OBIA (Object-Based Image Analysis) model, the thematic maps of the erosion risk areas of the research object, created on the basis of geospatial analysis of high-resolution GeoEye-1 satellite images, show erosion processes in mountain and foothill areas and recommended for use in automatic mapping.
10. Thematic maps showing factors causing erosion processes and annual soil loss due to these processes created on the basis of the RUSLE model, correct application of ecologically based soil protection measures to improve the condition of eroded soils, it was recommended to use it in the correct selection and placement of crop types in dry lands.

РАЗОВЫЙ СОВЕТ НА ОСНОВЕ НАУЧНОГО СОВЕТА DSc.03/27.02.2020.B.01.15 ПО ПРИСУЖДЕНИЮ УЧЕНЫХ СТЕПЕНЕЙ ПРИ НАЦИОНАЛЬНОМ УНИВЕРСИТЕТЕ УЗБЕКИСТАНА

НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ «ТАШКЕНТСКИЙ ИНСТИТУТ ИНЖЕНЕРОВ ИРРИГАЦИИ И МЕХАНИЗАЦИИ СЕЛЬСКОГО ХОЗЯЙСТВА»

ЖУЛИЕВ МУХИДДИН КОМИЛОВИЧ

ТЕОРЕТИЧЕСКИЕ ОСНОВЫ И МЕТОДОЛОГИЯ МОДЕЛИРОВАНИЯ ЭРОЗИОННЫХ ПРОЦЕССОВ В ГОРНЫХ И ПРЕДГОРНЫХ РЕГИОНАХ УЗБЕКИСТАНА (на примере Ташкентской области)

11.00.05 - Охрана окружающей среды и рациональное использование природных ресурсов

АННОТАЦИЯ АВТОРЕФЕРАТА ДИССЕРТАЦИИ ДОКТОРА БИОЛОГИЧЕСКИХ НАУК (DSc)

Ташкент – 2024

Тема диссертации доктора наук (DSc) по биологическим наукам зарегистрирована в Высшей аттестационной комиссии при Министерстве высшего образования, науки и инноваций Республики Узбекистан за номером B2024.1.DSc/B223.

Диссертация выполнена в Национальном исследовательском университете «Ташкентский институт инженеров ирригации и механизации сельского хозяйства».

Автореферат диссертации на трех языках (узбекский, английский, русский (резюме)) размещен на веб-странице Научного совета: (www.nuu.uz) и Информационно-образовательном портале “ZiyoNet” (www.ziyonet.uz).

Научный консультант:	**Гафурова Лазизахон Акрамовна** доктор биологических наук, профессор
Официальные оппоненты:	**Турабаев Акмал Нормуминович** доктор биологических наук, профессор
	Шадиева Нилуфар Искандаровна доктор биологических наук, доцент
	Хасан Одилович Бобоев доктор сельскохозяйственных наук, доцент
Ведущая организация:	**Ферганский государственный университет**

Защита диссертации состоится «24» августа 2024 г. в 10^{00} часов на заседании разового Научного совета на основе Научного совета по присуждению ученых степеней DSc.03/27.02.2020.B.01.05 при Национальном университете Узбекистана (Адрес: 100174, г. Ташкент, Алмазарский район, Студенческий городок, улица Университетская, дом 4, здание Экологического факультета Национального университета Узбекистана, 2-этаж, 203-комната. Тел.: (99871) 246-67-72.

С данной диссертацией можно ознакомиться в Информационно-ресурсном центре Национального университета Узбекистана (зарегистрирована за №72). Адрес: 100174, г. Ташкент, Алмазарский район, Студенческий городок, улица Университетская, дом 4. Тел.: (99871) 246-67-72.

Автореферат диссертации разослан «2» августа 2024 года.

(реестр протокола рассылки №19 от 2 августа 2024 г.).

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ВВЕДЕНИЕ (Аннотация диссертации доктора наук (DSc))

Целью исследования является оценка эрозионных процессов в горных и предгорных районах на основе геоинформационных технологий и методов дистанционного зондирования и усовершенствование методов моделирования эрозионных процессов почв.

Задачи исследования:

на основе опыта стран СНГ проанализировать работы по теме и по ним разработать стратегию геопространственного анализа при определении, оценке и создании моделей эрозионных процессов в горных и предгорных районах;

для применения модели RUSLE проанализировать природно-климатические условия региона с целью адаптации к модели природных факторов, вызывающих эрозионные процессы;

геопространственный анализ, основанный на расчете различных индексов периодических космических снимков с целью мониторинга данных о растительном покрове объекта исследования в зависимости от условий изменения климата;

геопространственный анализ первичной картографической, гидрометеорологической, регионально распределенной информации о подземных водах и спутниковых изображений, как основы применения модели MCDA;

выбор спутниковых изображений объекта исследования высокого разрешения в качестве основы для применения модели OBIA (Object-Based Image Analysis) и создание тематических карт зон эрозионного риска посредством геопространственного анализа.

создание тематических карт с данными о годовых потерях почвы вследствие эрозионных процессов на основе адаптированной к объекту исследования модели RUSLE.

Объектом исследования являются почвы, растительный покров, подземные воды и эрозионноопасные участки в горной и предгорной части Угам-Чаткальского национального парка.

Предметом исследований являются горные и предгорные почвы, динамика изменения растительного покрова, связь между подземными водами и эрозионным процессом, различные тематические карты, картирование и моделирование эрозионных процессов.

Методы исследования. Полевые и лабораторные исследования проводились по общепринятым методикам. Научные исследования проводились с использованием методов дистанционного зондирования Земли и ГИС-технологий. В частности, связь между ресурсами подземных вод и процессами эрозии почвы выполнена с применением модели MCDA (Multi-Criteria Decision Analysis), для геопространственного анализа спутниковых снимков использована модель OBIA (Object-Based Image Analysis), ежегодная потеря почвы в результате эрозии выполнена с использованием модели RUSLE, а также были рассчитаны индекс растительности (NDVI) и изменения

растительного покрова (LULC). Данные дистанционного зондирования Земли обрабатывались с использованием QGIS, Google Earth, Google Earth Engine, ArcGIS и других программ.

Научная новизна исследования заключается в следующем:

впервые создана научная библиометрическая база данных исследований по эрозии почв, проводимая в странах СНГ за последние 60 лет, разработана стратегия геопространственного анализа для выявления, оценки и моделирования эрозионных процессов в горных и предгорных районах;

в Угам-Чаткальском национальном парке в условиях изменения климата установлено использование результатов геопространственного анализа на основе расчетов вегетационных индексов спутниковых снимков для определения изменения показателей растительности и земного покрова территории за 20 лет;

впервые проведен геопространственный анализ эрозионных процессов на объекте исследования и анализ многокритериальных решений при определении взаимосвязи между подземными водными источниками и эрозионными процессами почвы с целью апробации моделей, преимуществ и усовершенствования возможностей модели MCDA;

впервые на объекте исследований был применен метод автоматического обнаружения эрозионных процессов по спутниковым снимкам высокого разрешения и оценены возможности модели OBIA (Object-Based Image Analysis);

для моделирования эрозионных процессов с помощью модели RUSLE на основе геопространственного анализа были адаптированы параметры модели RUSLE и усовершенствованы возможности с учетом особенностей объекта исследования.

Практические результаты исследования заключаются в следующем:

основа для моделирования эрозионных процессов создана с использованием разработанной стратегии выявления, оценки и моделирования эрозионных процессов в горных и предгорных районах;

на основе геопространственного анализа, обработки спутниковых изображений были рассчитаны индекс растительности (NDVI), изменение растительного покрова (LULC) и показатели осадков, а также разработаны тематические карты;

с помощью модели MCDA созданы тематические карты, отражающие связь между источниками подземных вод объекта исследования и процессами эрозии почвы, и на их основе классифицированы территории формирования потенциальных источников подземных вод;

с использованием модели OBIA (Object-Based Image Analysis) с возможностью автоматического картирования, путем геопространственного анализа спутниковых изображений объекта исследования высокого разрешения были выделены зоны риска эрозии и созданы тематические карты;

с учетом природно-климатических условий были скорректированы факторы, вызывающие эрозионные процессы, составляющие основу модели

RUSLE, и на их основе созданы тематические карты, отражающие данные ежегодных потерь почвы в результате эрозионных процессов.

Достоверность полученных результатов исследования. Достоверность результатов исследования отмечается подтверждением общепринятыми методами исследований и полученные теоритические результаты практическими данными, сравнением результатов исследования с результатами других авторов в сходном направлении и внедрением результатов исследования в практику.

Научная и практическая значимость результатов исследования.

Научная значимость результатов исследований объясняется интеграцией методов дистанционного зондирования и геопространственного анализа, использованием возможностей различных моделей при мониторинге эрозионных процессов на изучаемой территории, а также предоставлением точной информации при выявлении, оценке и создании моделей эрозионных процессов в горных районах.

Практическая ценность результатов исследований определяется тем, что созданные тематические карты служат при разработке ряда обоснованных экологических мероприятий по улучшению состояния эродированных территорий, при анализе состояния флоры и разработке мер, направленных на его защиту.

Апробация результатов исследования. Результаты данного исследования были обсуждены на 4-х международных и 2-х республиканских научно - практических конференциях и форумах.

Опубликованность результатов исследования. Всего по теме диссертации опубликовано 22 научные работы, в том числе 16 статей в научных изданиях, рекомендованных к публикации основных научных результатов докторских диссертаций ВАК РУз, в том числе 7 из них научных баз данных Scopus и Web of Science и в 11 республиканских журналах.

Структура и объём диссертации. Диссертация состоит из введения, 7 глав, выводов, приложения и списка использованной литературы. Общий объем диссертации составляет 172 страниц.

ЭЪЛОН ҚИЛИНГАН ИШЛАР РЎЙХАТИ
LIST OF PUBLISHED WORKS
СПИСОК ОПУБЛИКОВАННЫХ РАБОТ

I бўлим (I часть; I part)

1. Gafurova L., Juliev M. (2021) Soil Degradation Problems and Foreseen Solutions in Uzbekistan. Springer nature Switzerland AG 2021D. Dent and B. Boincean (eds.), Regenerative Agriculture, -pp. 59-67, https://doi.org/10.1007/978-3-030-72224-1_5.

2. Jasmina Gerts, Mukhiddin Juliev, Alim Pulatov, Multi-temporal monitoring of cotton growth through the vegetation profile classification for Tashkent province, Uzbekistan, GeoScape (2020) | Volume 14: Issue 1, -pp. 62-69, https://doi.org/10.2478/geosc-2020-0006.

3. Bokhir Alikhanov, Mukhiddin Juliev, Shahzoda Alikhanova, Ismail Mondal, Assessment of influencing factor method for delineation of groundwater potential zones with geospatial techniques. Case study of Bostanlik district, Uzbekistan, Groundwater for Sustainable Development, Volume 12, 2021, 100548, ISSN 2352-801X, https://doi.org/10.1016/j.gsd.2021.100548.

4. Juliev, M., Gafurova, L., Ergasheva, O., Ashirov, M., Khoshjanova, K., Mirusmanov, M. (2022). Land Degradation Issues in Uzbekistan. In: Al-Quraishi, A.M.F., Mustafa, Y.T., Negm, A.M. (eds) Environmental Degradation in Asia. Earth and Environmental Sciences Library. Springer, -pp. 163-176. https://doi.org/10.1007/978-3-031-12112-8_8

5. Jumaniyazov, I., Juliev, M., Reimov, M., Orazbaev, A., Reymov, T., Bekanov, K. (2023). Marginal lands: a review of papers from the Scopus database published in English for the period of 1979–2022. Soil Science Annual 2023, 74(2), 169657. https://doi.org/10.37501/soilsa/169657.

6. Juliyev Muxiddin, Xolmurodova Madinabonu, Gafurova Laziza, Djalilova Gulnora. Ugom-Chatqol davlat milliy tabiat bog'i uchun geoaxborot tizimlar va RUSLE modeli asosida tuproq eroziyasini modellashtirish. "Ekologiya xabarnomasi" №2/2023 ISSN 2010-703X. -B. 71-75.

7. B.Y. Maxsudov, M.K. Juliyev, N.N. Teshayev Ugom-Chotqol davlat milliy tabiat bog'ida yer qoplami va yerdan foydalanish holatining o'zgarishlarini multispektral kosmik tasvirlar asosida baholash. "O'zbekiston zamini". Ilmiy-amaliy va innovatsion jurnal. 3/2022. ISSN 2181-9955. -B. 55-61.

8. Juliyev Muxiddin, Xolmurodova Madinabonu, Gafurova Laziza, Djalilova Gulnora., Djonpulatova Z.A. Mustaqil davlatlar hamdo'stligida (MDH) tuproq eroziyasi mavzusida scopus bazasida chop etilgan maqolalar tahlili. "Ekologiya xabarnomasi" №3/2023 ISSN 2010-703X. -B. 83-85.

9. Juliyev Muxiddin, Xolmurodova Madinabonu, Gafurova Laziza. Tuproq eroziyasini baholashda modellashtirishning o'rni va ahamiyati. "Ekologiya xabarnomasi" №3/2022 ISSN 2010-703X. -B. 27-34.

10. Juliyev Muxiddin, Abdikairov Bekmurat, Gafurova Laziza. Application of

artificial neural network in land degradation. “O’zbekiston agrar fani xabarnomasi”, № 5 (11) 2023. -B. 147-150.

11. Juliyev Muxiddin, Abdikairov Bekmurat. Soil degradation problems in Karauzyak district of Karakalpakstan, Uzbekistan: Possibilities for applying RS and GIS. “O’zbekiston qishloq va suv xo’jaligi” jurnali, Maxsus son [2] 2023. ISSN 2181-502X. -B. 80-83.

12. Juliyev Muxiddin, Gafurova Laziza, Xolmurodova Madinabonu, Abdikairov Bekmurat. Ugom-Chotqol milliy bog’ining tuproqlari va tuproq eroziyasi bo’yicha tadbirlar: muammolar va saqlash strategiyasi. FarDu. Ilmiy xabarlar, 1/2024. ISSN 2181-1571. -B. 84-87.

13. Juliyev Muxiddin, Gafurova Laziza, Xolmurodova Madinabonu, Abdikairov Bekmurat. O’zbekistonda tuproq eroziyasining sabablari va eroziyaga tasir qiluvchi omillar. FarDu. Ilmiy xabarlar, 1/2024. ISSN 2181-1571. -B. 252-255.

14. Abdikairov Bekmurat, Juliyev Muxiddin, Gafurova Laziza, Xolmurodova Madinabonu. Tuproq sho’rlanishining 2000-2023 yillardagi holatini kuzatish. “O’zbekiston agrar fani xabarnomasi” №1(13) 2024. -B. 50-53.

15. Juliyev M.K., Gafurova L.A., Djanpulatova Z.A. Ekotizim xizmatlarining dunyo miqqiyosida rivojlanishi bo’yicha 2021-2023 yillar oralig’ida scopus ma’lumotlar bazasida nashr etilgan maqolalar tahlili. “O’zbekiston agrar fani xabarnomasi” №1(13) 2024. -B. 47-50.

16. Juliyev Muxiddin, Gafurova Laziza, Xolmurodova Madinabonu, Abdikairov Bekmurat. Ugom-Chotqol Milliy bog’ining iqlimi va gidrologik sharoiti. “Ekologiya xabarnomasi” №1[9] 2024, ISSN 2010-703X. -B. 60-63.

II bўлим (II часть; II part)

17. Juliev, M., Ng, W., Mondal, I., Begimkulov, D., Gafurova, L., Hakimova, M., Ergasheva, O., & Saidova, M. (2023). Surface displacement detection using object-based image analysis, Tashkent region, Uzbekistan. E3S Web of Conferences, 386, 04010. https://doi.org/10.1051/e3sconf/202338604010

18. M. Juliev, I. Jumaniyazov, I. Togaev, Sh. Toshtemirov, A. Samiev, I. Ochilov, K. Usmanov, and M Saidova Land degradation in Central Asia: a review of papers from the Scopus database published in English for the period of 2000-2020, E3S Web of Conf., 462 (2023) 03020, DOI: https://doi.org/10.1051/e3sconf/202346203020

19. М.К. Жулиев, Л.А.Гафурова. Перспективы применения современных технологий при моделировании эрозионных процессов. Современные проблемы изучения почвенных и земельных ресурсов. Сборник докладов III Всероссийской открытой конференции. 2019, -С.48-53.

20. Гафурова Л.А, Джалилова Г.Т, Жулиев М.К. Картирование эрозии почвы с использованием интеграции дистанционного зондирования и ГИС. Почвы-стратегический ресурс России. Материалы VIII съезда Общества почвоведов им. В.В. Докучаева и Школы молодых ученых по морфологии и классификации почв. Сыктывкар, 2020-2022, -С.838-839.

21. Жулиев М.К, Гафурова Л.А. Геоахборот тизимлари ва масофадан

зондлаш технологияларидан атроф муҳит ҳақидаги фанларда фойдаланишнинг истиқболлари. “Ўзбекистонда илмий-амалий тадқиқотлар” мавзусидаги республика 16-кўп тармоқли илмий масофавий онлайн конференция материаллари 12-қисм. Тошкент, 2020. -Б. 177-179.

22. Juliev M.K, Gafurova L.A, Jalilova G.T. Remote Sensing and GIS based analysis of soil erosion processes. Сборник материалов Республиканского научно-практического онлайн семинара “Актуальные проблемы почвоведения. Инновационые технологии - основы устойчивого управления почвенными ресурсами”. 2020. -С. 142-146.

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