GIS Modeling and Analytics in Regional Planning

May 16, 2023

Toolbox Tuesday

WWW.SCAG.CA.GOV

Housekeeping

1. Meeting length: 1.5 hour
2. This meeting is being recorded
3. All participant lines will be muted
4. At the end, there will be a Q&A session
5. If you have a question during the presentation, please type it into the chat box or press the "raise hand" function
6. We will log all questions and then voice a selection at the end of the presentation
7. A recording of this webinar and the PowerPoint slides will be available on the SCAG website. We will send a link to everyone who has registered after the event

Agenda

1. SCAG Regional Planning	1:00 – 1:10 p.m.
2. GIS for Regional Planning	1:10 – 1:20 p.m.
3. GIS Modeling & Analytics	1:20 – 1:40 p.m.
4. Demo: GIS Programming & Automation	1:40 – 2:00 p.m.
5. Q&A	2:00 – 2:15 p.m.

SCAG REGIONAL PLANNING

About SCAG

191 Cities

6 Counties

19 Million People

5 MM Parcels

16th Largest Economy in the World

SCAG REGION STATISTICS

KEY INDICATORS

- **487** 2020 PERSONS PER SQUARE MILE
- **2.99** 2020 AVERAGE HOUSEHOLD SIZE
- **8%** 2021 POPULATION AGE 25+; NO DIPLOMA (%)
- **33%** 2021 POPULATION AGE 25+; BACHELOR'S DEGREE OR HIGHER EDUCATION (%)
- **$629K** 2021 MEDIAN HOME VALUE

EMPLOYMENT

- **22%** 2021 BLUE COLLAR WORKERS
- **63%** 2021 WHITE COLLAR WORKERS
- **16%** 2021 SERVICE WORKERS

COMMUTE

- **19%** 2021 WORKERS WHO COMMUTE 7+ HOURS WEEKLY
- **76.1%** 2019 WORKERS WHO DRIVE ALONE TO WORK

BUSINESS

- **790K** 2021 TOTAL BUSINESS ESTABLISHMENTS
- **7.7M** 2021 TOTAL EMPLOYEES

DAYTIME POPULATION

- **8.4M** 2021 WORKERS
- **10.4M** 2021 RESIDENTS
- **91%** 2021 EMPLOYED CIVILIAN POPULATION AGE 16+

HOUSING

- **24.7M** TOTAL ACRES
- **53%** 2021 OWNER OCCUPIED HOUSING UNITS
- **47%** 2021 RENTER OCCUPIED HOUSING UNITS

FINAL 6TH CYCLE REGIONAL HOUSING NEEDS ASSESSMENT (RHNA) ALLOCATION

1,341,827 HOUSING UNITS

- **559,267** ABOVE MODERATE INCOME (>120% OF AMI)
- **351,796** VERY LOW INCOME (<50% OF AMI)
- **206,807** LOW INCOME (50-80% OF AMI)
- **223,957** MODERATE INCOME (80-120% OF AMI)

SCAG RDP

More information on the SoCal Atlas tool can be found at https://rdp.scag.ca.gov/socal-atlas/

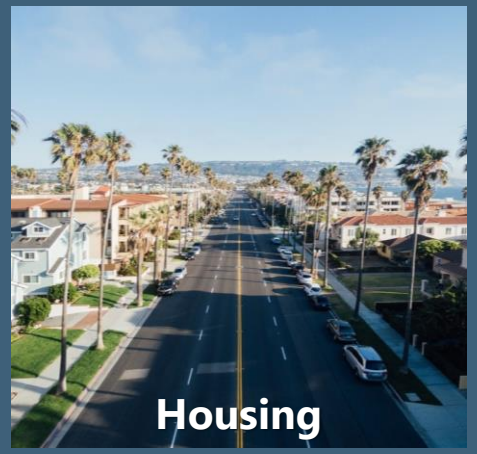
KEY INDICATORS DATA SOURCE: 2020 data are from the 2020 Decennial Census PL-94 redistricting file which and have been processed by the California Department of Finance. 2021 data are Esri estimates (additional information on Esri demographics can be found at https://doc.arcgis.com/en/esri-demographics/latest/regional-data/united-states.htm).

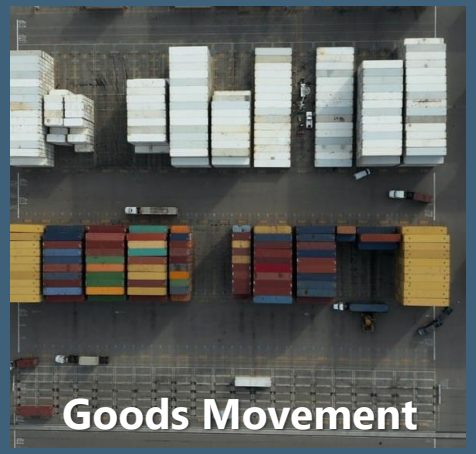
HOUSING DATA SOURCE: 2020 data are from the 2020 Decennial Census PL-94 redistricting file which has been processed by the California Department of Finance. 2021 data are Esri estimates (additional information on Esri demographics can be found at https://doc.arcgis.com/en/esri-demographics/latest/regional-data/united-states.htm). RHNA information are from SCAG. For additional housing data for SCAG jurisdictions, please refer to the Pre-certified Local Housing Data Reports (https://scag.ca.gov/housing-elements) developed for 6th cycle housing element updates.

EMPLOYMENT DATA SOURCE: 2021 data are Esri estimates (additional information on Esri demographics can be found at https://doc.arcgis.com/en/esri-demographics/latest/regional-data/united-states.htm). Specific information on the categorization of White Collar, Blue Collar, and Services employees can be found at https://doc.arcgis.com/en/esri-demographics/latest/reference/faq.htm#anchor15, along with additional information on Daytime population counts at https://doc.arcgis.com/en/esri-demographics/latest/reference/faq.htm#anchor14. 2019 data are from the American Community Survey (ACS) and have been processed and published by Esri.

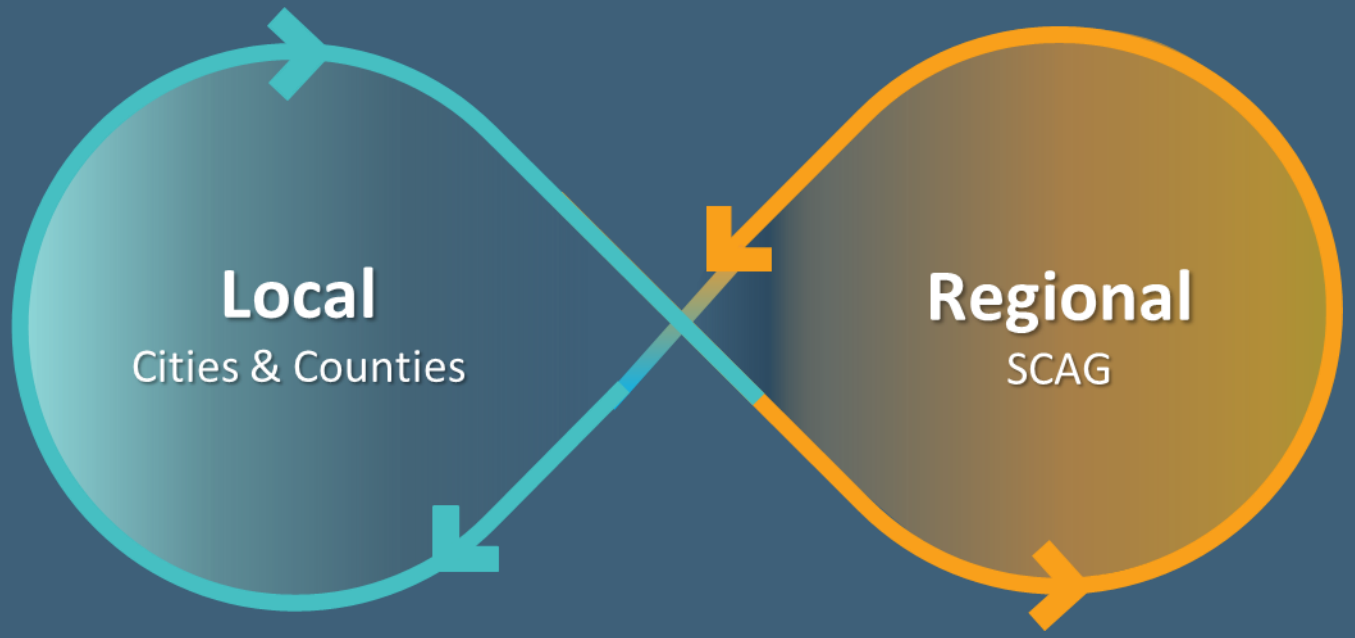
The Region Faces Big Challenges…

Regional Planning Context





Planning, Engagement & Data Sharing



- Struggle to update local General Plan
- Need data, tools, resources, and support

- Struggle to do regional forecasting & planning
- Need accurate, complete, and current local data

70%
of local agencies lacked technical staff to analyze data

43%
had no in-house GIS support

84%
shared data through email or other means of direct communication

Connect SoCal?

- 20+ year plan with 6,000+ transportation projects, regional development pattern and goal-oriented programs and strategies.
  - Mobility, Environmental, Community, and Economic Goals
  - Reduce congestion and travel times
  - Increase opportunities to walk, bike or take transit
  - Reduce greenhouse gas emissions and other pollutants
  - Conserve open space and farmland
  - Improve access to transit and jobs and meet regional housing needs
  - Support new jobs, improved competitiveness
  - Facilitate efficient and resilient goods movement

Local Data Exchange

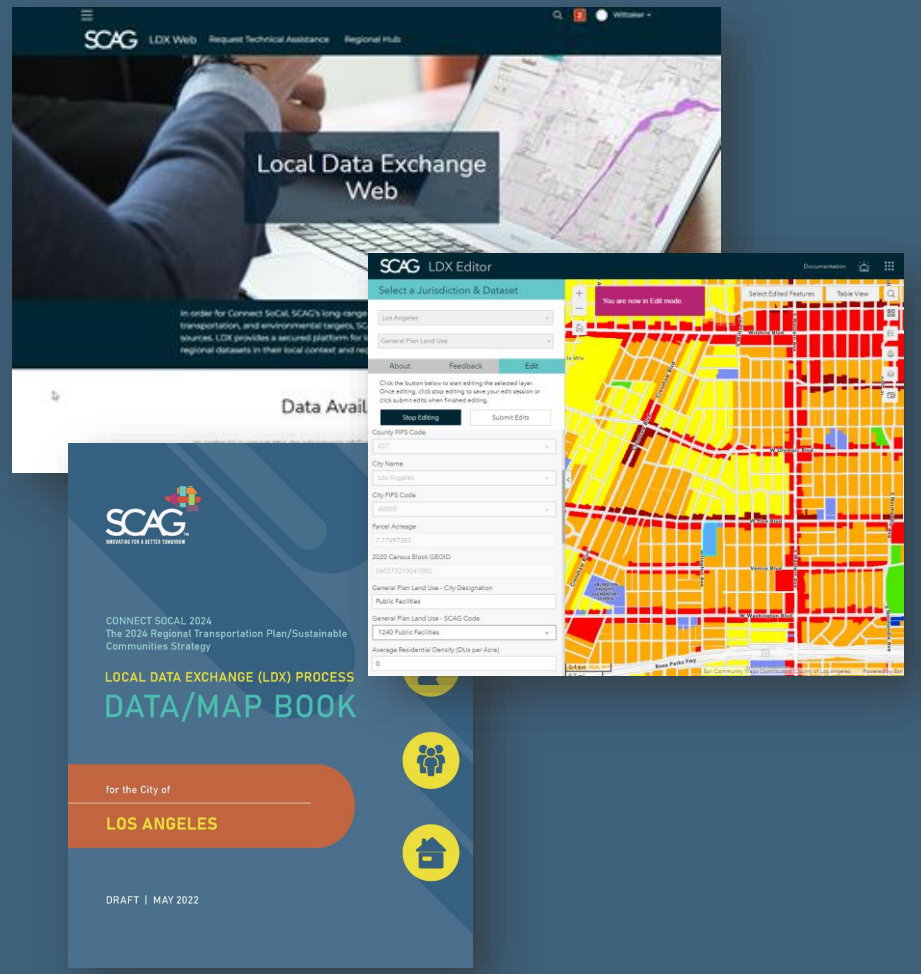
Solicit updates and corrections to:

1. Local land use data
2. Preliminary forecast of households and employment growth

Feedback and editing opportunity on:

Additional growth and transportation data

Opportunity to align local and regional visions



GIS FOR REGIONAL PLANNING

GIS and Planning

GIS: More than just a map

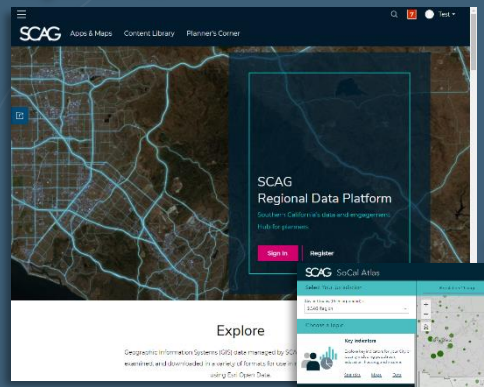
- Data management
- Visualization
- Analysis & modeling
- Sharing & engagement

Source: Esri

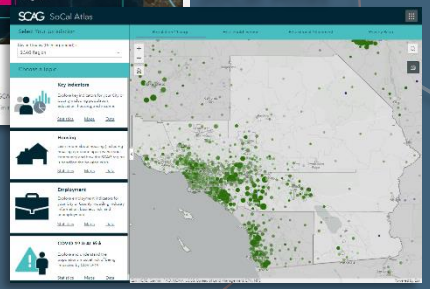
Regional Data Platform (RDP)

Accessible Data and Information

Regional Hub

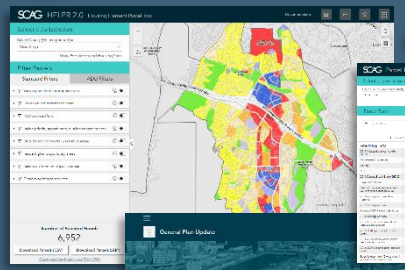


SoCal Atlas

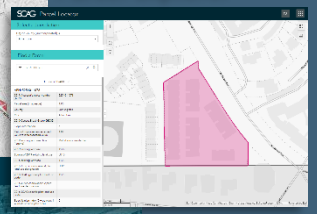


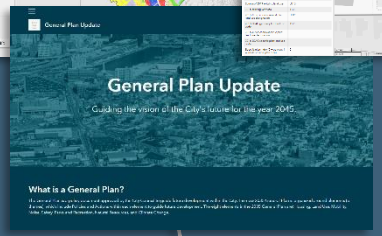
Planning & Engagement Tools

HELPR



Parcel Explorer

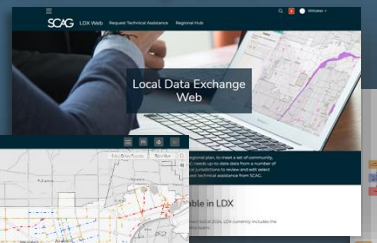




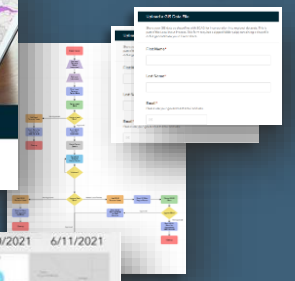
General Plan Update Initiative Templates

Data Sharing Tools & Workflows

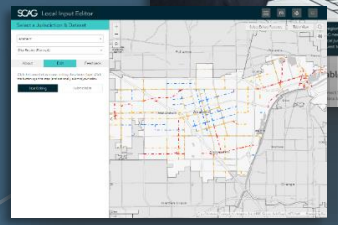
Local Data Exchange (LDX) Web



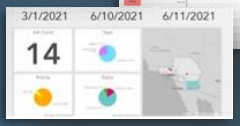
LDX Data Upload



LDX Editor



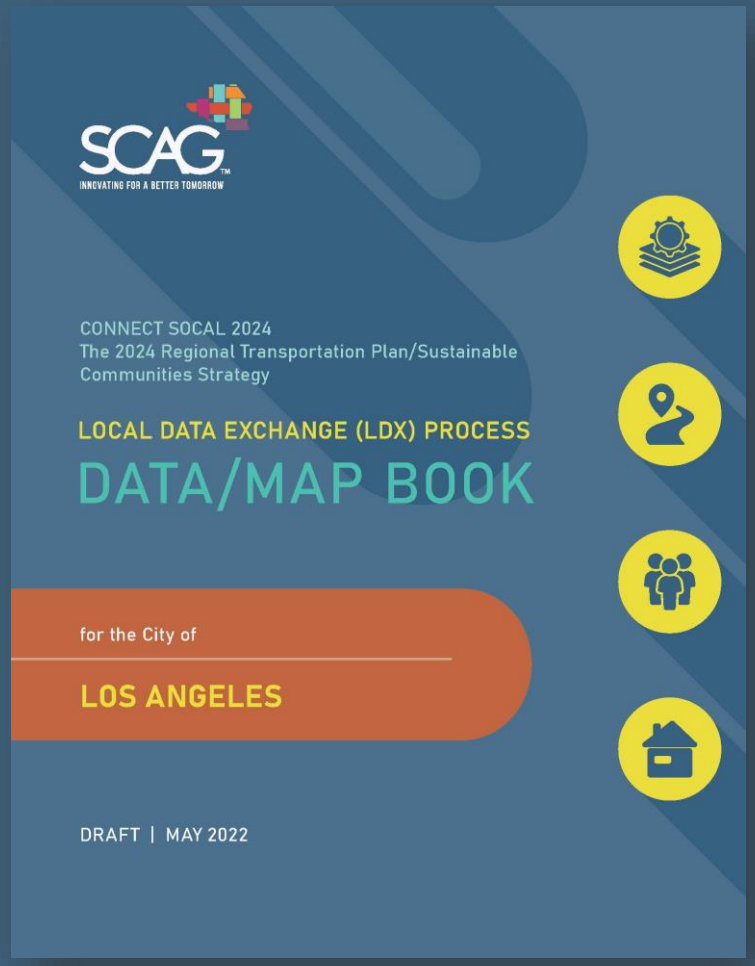
LDX Workflow Management



SCAG Regional Data Platform (RDP)

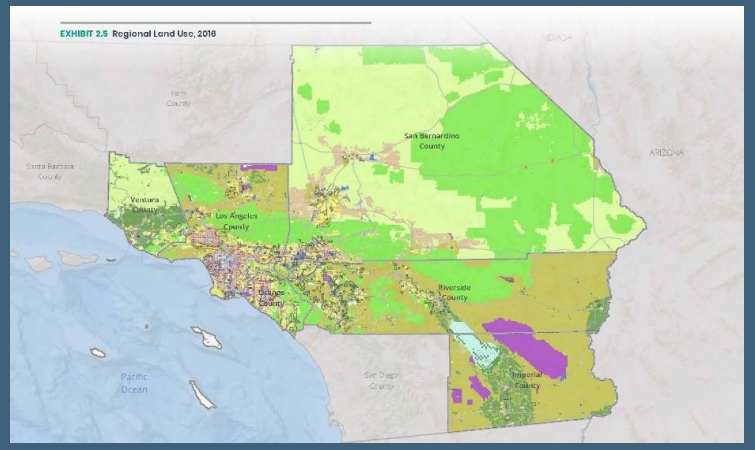
Data/Map Books

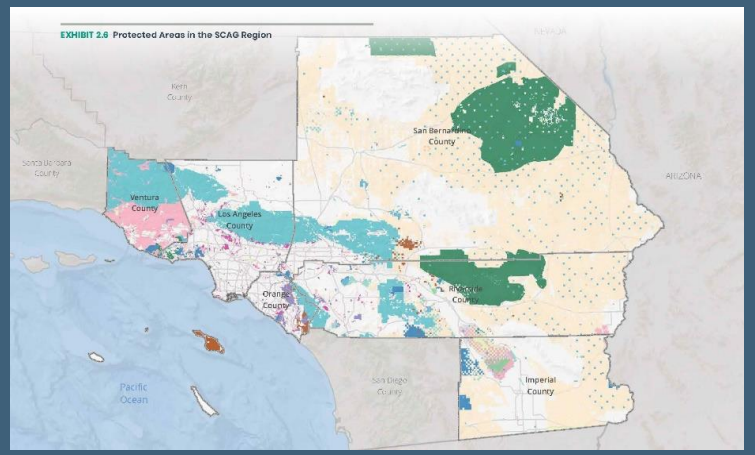
- Producing Data/Map Books of 197 local jurisdictions for Connect SoCal Local Data Exchange (LDX) process
- To help local planners better understand the sources, methodologies, and contexts of SCAG GIS datasets
- Including 30+ maps of:
  - Land Use
  - Priority Development
  - Transportation
  - Green Region Resource Areas
  - Geographical Boundaries
  - Growth Forecasts



Geospatial Data for Connect SoCal

- Smart Land Information System
  - Regional land use information at the parcel-level for 6 counties and 191 cities (app. 5 million parcels)
  - Major land use information: General plan, specific plan, zoning and existing land use
  - Quadrennial and Annual Land Use dataset
  - Other value-added land information
- Growth strategy analysis
  - Priority Development Areas, Neighborhood Mobility Areas, Job Centers, High Quality Transit Ares, Transit Priority Areas, etc.
- Resource areas (e.g., open space, farmland, etc.)
- Transportation (e.g., truck routes, bikeways, etc.)

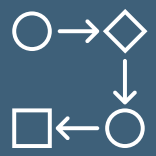




SCAG GIS MODELING & ANALYTICS

GIS and Programming

- Data Analysis and Data Manipulation
  - Customize available geospatial tools and libraries to facilitate GIS work



- Workflow Automation
  - Streamline the workflow
  - Reduce repeat work

- Easy User Interface
  - Develop easy to use tool for everyone

SCAG GIS Modeling and Analytics

- Developing an effective GIS workflow to streamline:
  - High-volume regional geospatial data development
  - Repetitive and complicated geoprocessing
  - Redundant map book compilation and production tasks
- Utilizing ArcGIS and programming skills to develop workflow automation that offers benefits in
  - Time and labor savings
  - Better data quality, accuracy and consistency

GIS Programming for Geospatial Data Development

- High-volume parcel data processing
  - To manipulate over 5.6 MM property characteristics and app. 5 MM parcel polygon features
  - Obtained from multiple sources
- GIS programming for parcel data management
  - To streamline repetitive and complicated data manipulation and standardization process of high-volume parcel data,
  - To convert local land use codes into SCAG's standardized land use classification
  - To ensure data consistency and accuracy (e.g. duplicate/null record clean-up, feature comparison, spatial match, etc.)

```
# Define shapefiles and file geodatabase
cntyFC = "P:/=existing_landuse_2016/shapes/LandUse_poly_scag.gdb/LandUse_poly_" + cnty
cityFC = "P:/=existing_landuse_2016/shapes/LandUse_poly_" + cnty + ".gdb/" + cityName

# Count the totel number of features in file geodatabase
cntRow = arcpy.GetCount_management(cityFC)

# Make a layer from the feature class
arcpy.MakeFeatureLayer_management(cntyFC, "gdb_cnty")
arcpy.MakeFeatureLayer_management(cityFC, "gdb_city")

# Join the file geodatabase with dbf file by SCAGUID16
print "===== Start join process ====="
print "Input file: " + cityFC
print "Target file: " + cntyFC

joinField = "SCAGUID16"
arcpy.AddJoin_management("gdb_cnty", joinField, "gdb_city", joinField)

print "===== Start update process ====="

# Select joined features and update values
expression = '"' + cityName + ".SCAGUID16" + '"' + " IS NOT NULL"
arcpy.SelectLayerByAttribute_management("gdb_cnty", "NEW_SELECTION", expression)

# Count the selected features
cntSelect = arcpy.GetCount_management("gdb_cnty")

arcpy.CalculateField_management("gdb_cnty", "LandUse_poly_" + cnty + ".LU16", "!" + cityName + ".LU16!", "PYTHON_9.3")
print "Updated: LU16"
arcpy.CalculateField_management("gdb_cnty", "LandUse_poly_" + cnty + ".NOTES", "!" + cityName + ".NOTES!", "PYTHON_9.3")
print "Updated: NOTES"
arcpy.CalculateField_management("gdb_cnty", "LandUse_poly_" + cnty + ".LU16_2ND", "!" + cityName + ".LU16_2ND!", "PYTHON_9.3")
print "Updated: LU16_2ND"
arcpy.CalculateField_management("gdb_cnty", "LandUse_poly_" + cnty + ".RATIO_2ND", "!" + cityName + ".RATIO_2ND!", "PYTHON_9.3")
print "Updated: RATIO_2ND"
```

```
import pandas as pd
from arcgis.features import GeoAccessor
import numpy as np
import arcpy
import os

summ_path = r"P:\=specific_plan\=specific_plan_2019\tables\=Phase_II_QC\QC_SP_summary_city.xlsx"
REPORT_TABLE = pd.read_excel(summ_path, sheet_name="summ")

REPORT_TABLE["INDEX"] = REPORT_TABLE["INDEX"].astype('string')
REPORT_TABLE["PLAN_NAME"] = REPORT_TABLE["PLAN_NAME"].astype('string')
REPORT_TABLE["PARCEL_OUT_BNDRY"] = REPORT_TABLE["PARCEL_OUT_BNDRY"].astype('string')

cnty_dict = {"Imperial": "IM", "Los Angeles": "LA", "Orange": "OR",
             "Riverside": "RV", "San Bernardino": "SB", "Ventura": "VN"}

COUNTY_global = ""

for idx, row in REPORT_TABLE.iterrows():
    COUNTY = row["COUNTY"]
    CITY = row["JURISDICTION"]
    CNTY = cnty_dict[COUNTY]
    CITY = CITY.replace(" ", "_")
    print(COUNTY, " ", CITY)

    if COUNTY != COUNTY_global:
        REPORT_TABLE.to_excel(summ_path, sheet_name='summ', index=False)
        COUNTY_global = COUNTY

    result = {}
    # 1. load city-level parcel and boundary data
    parcel = r"P:\=specific_plan\=specific_plan_2019\shapes\Specificplan_poly_" + CNTY + ".gdb" + "\\" + CITY
    boundary = r"P:\=specific_plan\=specific_plan_2019\shapes\Specificplan_boundary_" + CNTY + ".gdb" + "\\" + CITY
    if not arcpy.Exists(boundary):
        result["INDEX"] = "Passed"
        result["PLAN_NAME"] = "Passed"
        result["PARCEL_OUT_BNDRY"] = "Passed"
        REPORT_TABLE.at[idx, "INDEX"] = result["INDEX"]
        REPORT_TABLE.at[idx, "PLAN_NAME"] = result["PLAN_NAME"]
        REPORT_TABLE.at[idx, "PARCEL_OUT_BNDRY"] = result["PARCEL_OUT_BNDRY"]
        print(result)
        continue

    out_folder = r"P:\Mengdi\ConnectSoCal2024\shapes"
    gdb = "QC_SP_poly_" + CNTY + ".gdb"
    outGDB = os.path.join(out_folder, gdb)

    if not os.path.exists(outGDB):
        arcpy.CreateFileGDB_management(out_folder, gdb)

    out_feature = os.path.join(outGDB, CITY)

    # 2. spatial join parcel and boundary (any parcel HAVE_THEIR_CENTER_IN the boundary, one to many match)
    arcpy.env.workspace = gdb
    arcpy.env.overwriteOutput = True
    arcpy.SpatialJoin_analysis(parcel, boundary, out_feature, "JOIN_ONE_TO_MANY", "KEEP_ALL", "#",
                               "HAVE_THEIR_CENTER_IN")
```

GIS Programming for Spatial Analysis and Geoprocessing

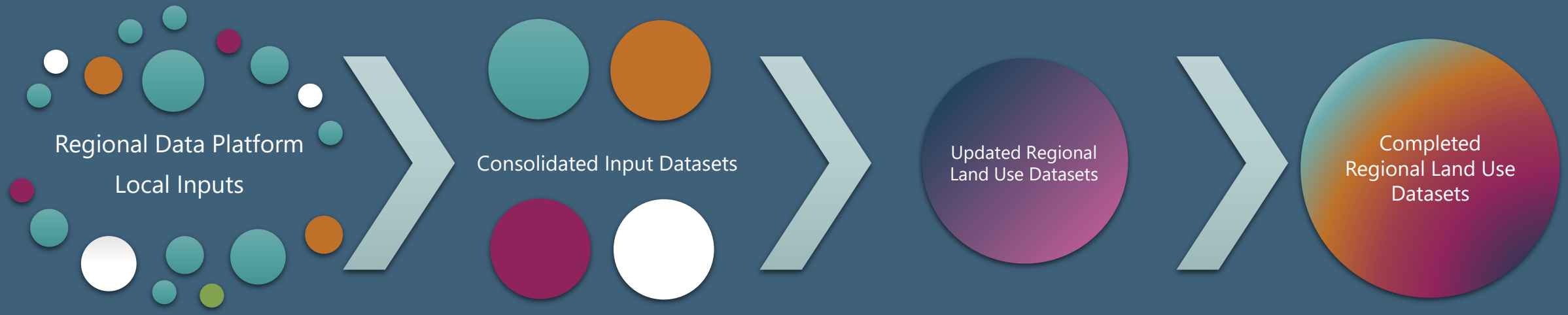
- High-Quality Transit Area & Transit Priority Areas
  - Identifying the intersection of 2+ major bus routes with a frequency of service interval of 15 min. or less during the peak periods
  - Python scripts to counting stops within 500 ft buffer of over 8,000 intersections of high-quality bus routes and to calculate the angles of high-quality bus routes intersections
- Growth Strategy Analysis for Connect SoCal
  - Estimating households and employment growth in various land use strategies for different growth forecast scenarios
  - Python scripts to streamline repetitive process and to ensure consistent methodology

```python
# Create the intersection of the target buffer and selected hqtc routes
bffr_hqtc_int_multi = "bffr_hqtc_int_multi"
arcpy.Intersect_analysis([bffr_target, hqtc_angle], bffr_hqtc_int_multi, "ALL", "", "POINT")
bffr_hqtc_int = "bffr_hqtc_int"
arcpy.MultipartToSinglepart_management(bffr_hqtc_int_multi, bffr_hqtc_int)

# Calculate the centroid x and y of intersection of buffer and hqtc
arcpy.AddField_management(bffr_hqtc_int, "INT_X", "DOUBLE")
arcpy.CalculateField_management(bffr_hqtc_int, "INT_X", "!SHAPE.CENTROID.X!", "PYTHON_9.3")
arcpy.AddField_management(bffr_hqtc_int, "INT_Y", "DOUBLE")
arcpy.CalculateField_management(bffr_hqtc_int, "INT_Y", "!SHAPE.CENTROID.Y!", "PYTHON_9.3")
bffr_hqtc_int_dissolve = "bffr_hqtc_int_dissolve"
dissolveFields = ["ORIG_FID", "POINT_X", "POINT_Y", "INT_X", "INT_Y"]
arcpy.Dissolve_management(bffr_hqtc_int, bffr_hqtc_int_dissolve, dissolveFields)
bffr_hqtc_pnt = "bffr_hqtc_pnt"
arcpy.MultipartToSinglepart_management(bffr_hqtc_int_dissolve, bffr_hqtc_pnt)

# Calculate the distance between centroids and intersection of buffer and hqtc
arcpy.AddField_management(bffr_hqtc_pnt, "DIST_X", "DOUBLE")
arcpy.CalculateField_management(bffr_hqtc_pnt, "DIST_X", "!INT_X!-!POINT_X!", "PYTHON_9.3")
arcpy.AddField_management(bffr_hqtc_pnt, "DIST_Y", "DOUBLE")
arcpy.CalculateField_management(bffr_hqtc_pnt, "DIST_Y", "!INT_Y!-!POINT_Y!", "PYTHON_9.3")

# Calculate the angles of intersections
anglist = []
with arcpy.da.UpdateCursor(bffr_hqtc_pnt, ['POINT_X', 'POINT_Y', 'INT_X', 'INT_Y']) as cursor2:
    for row2 in cursor2:
        cent_x = row2[0]
        cent_y = row2[1]
        int_x = row2[2]
        int_y = row2[3]
        dist_x = cent_x - int_x
        dist_y = cent_y - int_y

        if dist_x < 0 and dist_y <= 0:
            angle = math.degrees(math.atan(abs(dist_y/dist_x)))
        elif dist_x <= 0 and dist_y > 0:
            angle = math.degrees(math.atan(abs(dist_x/dist_y))) + 270
        elif dist_x > 0 and dist_y >= 0:
```

GROWTH STRATEGY ANALYSIS FOR FINAL CONNECT SOCAL GROWTH VISION

FINAL PLAN	AREA		GROWTH				SHARE OF TOTAL GROWTH			
	ACRES	%	HO08 - HO16	HO16 - HO45	E08 - E16	E16 - E45	HO08 - HO16	HO16 - HO45	E08 - E16	E16 - E45
SCAG TOTAL	24,717,287		197,781	1,621,920	650,783	1,659,857				
Priority Growth Areas	**975,234**	**3.9%**	**139,795**	**1,041,318**	**485,600**	**1,232,364**	**70.7%**	**64.2%**	**74.6%**	**74.2%**
High Quality Transit Areas[1]	592,286	2.4%	115,013	830,905	294,289	997,212	58.2%	51.2%	45.2%	60.1%
Transit Priority Areas (TPA)[1]	218,411	0.9%	67,002	491,028	135,892	623,845	33.9%	30.3%	20.9%	37.6%
Job Centers	202,186	0.8%	47,816	390,688	217,165	502,749	24.2%	24.1%	33.4%	30.3%
Neighborhood Mobility Areas	248,916	1.0%	73,938	469,292	179,563	491,877	37.4%	28.9%	27.6%	29.6%
Livable Corridors[2]	548,451	2.2%	98,024	748,306	350,001	826,170	49.6%	46.1%	53.8%	49.8%
Sphere of Influence[3]	146,017	0.6%	5,846	71,956	16,790	29,478	3.0%	4.4%	2.6%	1.8%
Absolute Constrained Areas[4]	20,487,984	82.9%	22,570	157,798	32,416	150,815	11.4%	9.7%	5.0%	9.1%
Variable Constrained Areas[5]	17,924,688	72.5%	104,702	768,181	292,001	712,860	52.9%	47.4%	44.9%	42.9%

GIS Programming for Workflow Automation



- ArcGIS Python API
- ArcGIS REST API
- ArcGIS Workflow Manager
- ArcGIS GeoAccessor – Spatial Enabled Pandas DataFrame

- Spatial Analysis Tool
- Data Migration Tool
- Data Conversion Tool
- Quality Control Tool

- GIS Data and Correspondence Table Consistency Review Tool
- Spatial Consistency Review Tool

GIS Programming for Data Visualization

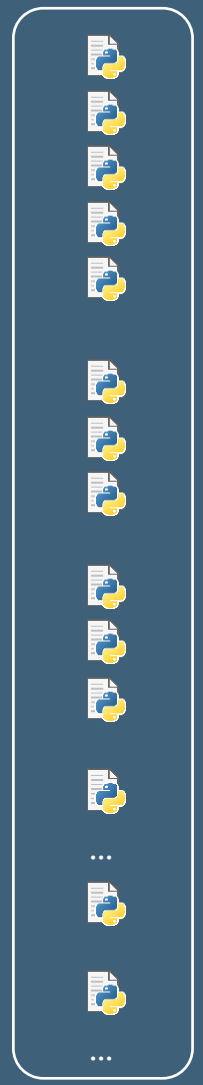
- General Plan
- Specific Plan
- Zoning
- Existing Land Use
- Entitlement

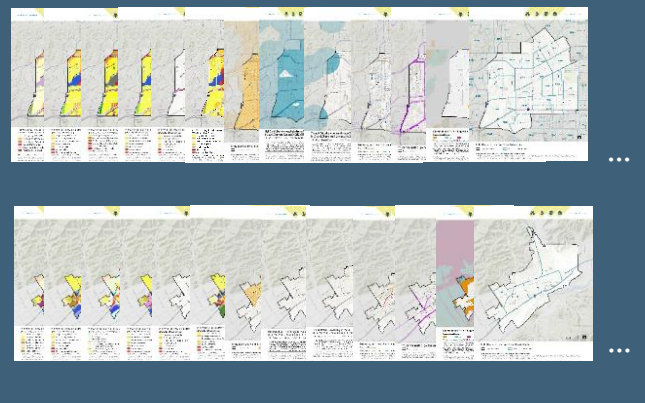
- Job Centers
- Livable Corridors
- Neighborhood Mobility Area

- High Quality Transit Area
- Bikeway
- Truck Routes

- GRRA - Conservation
- ...
- GRRA - Flood

- Admin Boundary
- ...

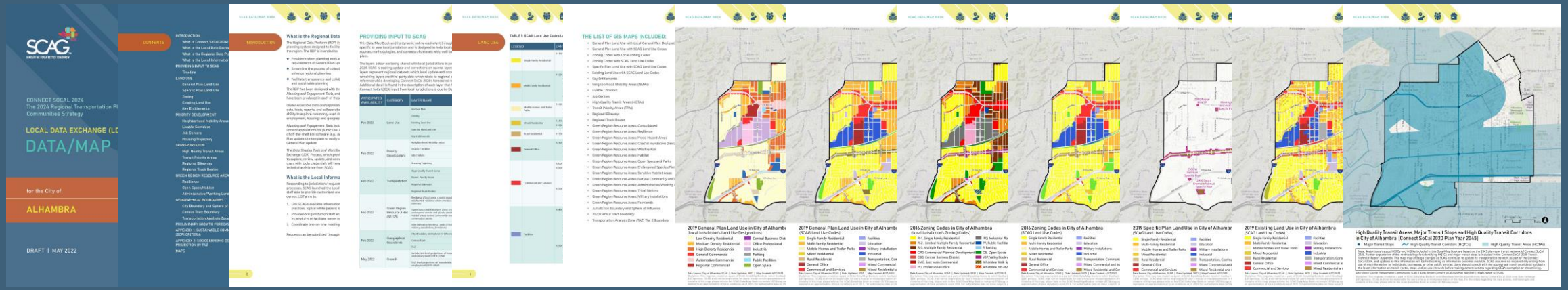


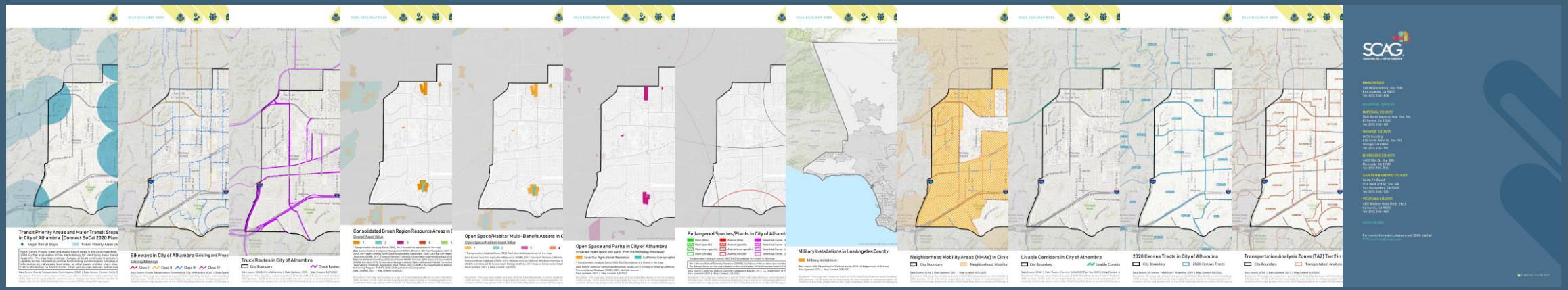


Combined maps for 197 local jurisdictions

Combined customized texts, figures and maps for 197 local jurisdictions

GIS Programming for Data Visualization (cont.)





DEMO: GIS PROGRAMMING & AUTOMATION

THANK YOU!

Tell us how we did!

Take a quick 2-minute survey to help us improve future Toolbox Tuesdays!