**From (Dixon et al. 2012)**

In San Gabriels low gradient hillslopes (<25dgr), chemical weathering increases with increasing erosion rates, but on high gradient hillslopes (>25dgr), chemical weathering intensities and rates decrease as erosion rates increase (Dixon et al. 2012).

N input from anthropogenic acidity (HNO3)

Anthropogenic acidity from Los Angeles metropolitan area, estimated to produce 33 g Nitrogen (m^-2) (y^-1) in San Gabriels (Riggan et al., 1985)

Nitrogen Deposition rates have been estimated to be <1g N (m^-2) (y^-1) in San Gabriels (Keifer and Fenn, 1997; metadata Tonnesen et al. 2007; 2002 raster data, R. Johnson, pers. Comm.)

Acidic input of HNO3 is poorly constrained (wet vs dry effect on weathering poorly constrained)

**From (Thanos & Rundel, 1995)**

Soils of California are typically low in total N and total P concentrations (Rundel, 1982) (what does low mean?, read paper)

Nitrogen availability may be the limiting factor for plant growth in California soils (Rundel, 1982)

Nitrate-nitrogen is apparently deficient in many chaparral soils in sharp contrasts to it’s comparatively high concentrations after burning (Christensen, 1973).

During the first postfire year, soil measurements have shown an increase of ammonium and nitrate concentrations in California Chaparral Ecosystems

Chamise chaparral (Rundel, 1983)

Surface of chaparral soil (Sampson, 1944)

Dense chaparral dominated by chamise (Christensen, 1973)

**From (Vourlitis, 2007)**

def

Soil extractable nitrogen (N) = organic N extracted by water or salt solutions

In this study total soil N positively correlated with N deposition exposure before

Fire caused increase in soil extractable N which was positively correlated with N deposition, indicating that fire enhances soil N availability more at sites exposed to high N deposition

Anthropogenic N-deposition is significant in chaparral in southern California (Fenn et al., 2003a; Phoenix et al., 2006).

Of gaseous and particulate N pollutants, the majority (85-95%) fall as dry deposition during the summer when **inversion** conditions trap these pollutants near the land surface (Bytnerowicz and Fenn, 1996; Fen et al., 2003a).

Chaparral Ecosystems are considered N limited (Fenn et al., 2003b; Gray and Schlesinger, 1983; Kummerow et al., 1982).

Atmospheric N inputs can increase total and available N through direct fertilization and enhanced mineralization, reduce soil C:N ratios, enhance soil acidification, and promote losses of N from gaseous efflux and leaching (Fenn et al. 2003b; Meixer and Fenn, 2004; Michalski et al., 1999, Riggan et al., 1985; Vourlitis et al., 2007a, b).

Fire consumes above ground biomass, surface litter, and SOM, which depending on intensity, causes losses in ecosystem N storage (Debano and Conrad, 1978; Debano et al., 1979), while other processes such as leaching, erosion, and/or runoff can cause additional and substantial losses of ecosystem N during the initial stages of chaparral succession (Gray and Schlesinger, 1981; Riggan et al., 1985, 1994).

Ash deposited from the charred remains of shrubs and litter is rapidly mineralized following fire causing a transient increase in available N, especially NH4 (Carreira et al., 1994; Fenn et al., 1993; Riggan et al., 1985, 1994; Stock and Lewis, 1986).

Some plants and shrubs that re-colonize following fire are capable of symbiotic N fixation, which can add an additional 2-40 kg N/ha y {convert to g N/(y m^2)} to recovering chaparral (Ellis and Kummerow, 1989; Poth, 1982) so potential loss of N may be rapidly offset by input via N fixation.

**From (Burton et al., 2016)**

In fire perimeter 62% moderate severity, 11% high severity, 27% low severity or unburned [http://www.fs.usda.gov/Internet/FSE\_DOCUMENTS/stelprdb5245056.pdf]

**From (Debano et al., 1978)**

Nitrogen is particularly susceptible to volitization by heating, and significant amounts of gaseous N can be lost above 300C (DeBell and Ralston, 1970; Knight, 1966; White el al., 1973).

**The Effect of Fire on Soil Properties – Debano 1990**

Because of close relationship between C and N, C:N ratios play an important roll in regulating decomposition rate of SOM, as a result control the rate at which N and other nutrients are released and cycled (Turner, 1977).

Response of different nutrients to heating indicate that little change is likely to occur more than 4-5 cm below the soil surface, unless a very long very intense duration occurs (example, burning a pile of logs).

Nutrient availability of N can increase with depth after a burn because steep temperature gradients are produced in upper soil layers during the combustion of litter and humus on the soil surface where surface temperatures may exceed 1000C, while poor heat conduction results in temperatures of 200C or less at 5cm depth. As a result, some vaporized SOM and ammonium-rich compounds released during combustion are transferred downwards where they condense in cool underlying soil (Debano and others 1976).

While large amounts of N is lost during combustion, available NH4-Nitrogen is usually higher in underlying soil following fire because of the transfer mechanism (above) (Debano and others 1979).

The increase in N availability as NH4-Nitrogen observed immediately after fire appears to be related to soil temperature in that under extremely hot fire, most of the N is probably volatized, particularly near the soil surface, while only small amounts are transferred downwards, while in cooler soil heating regimes, substantial NH4-Nitrogen can be found in ash and underlying soil.

**From (Barro and Conrad, 1991)**

While to pool of total nitrogen decreases with each fire, the concentration of available N in the form of ammonium and nitrate increases after fire (Debano et al., 1979).

Contributors of post fire chaparral ecosystem nitrogen replacement likely include nitrogen fixing bacteria and shrubs.

**Effects of Fire on Chaparral Soils in Arizona and California and Postfire Management Implications – Debano 1988**

Studies in California chaparral showed that 150 Kg/ha of N were lost by volatization and an additional 15 kg/ha by erosion after fire (Debano and Conrad 1976, 1978), which represents about 11% of the N in plants, litter and the upper 10 cm of soil before burning

(Debano and Conrad 1976, 1978) (I think I looked at atleast one of these)

Mechanisms for restoring N include input by bulk precipitation, and N-fixing plants and microorganisms.

Bulk precipitation is estimated to restore 1.5 kg/ha annually, which is not sufficient to restore N lost if chaparral burns every 25-35 years (Ellis and others, 1983).

N input may be greater in localized areas with large airborne N pollutants present. Riggen and others (1985) found annual inputs of 23.3 and 8.2 kg/ha as canopy through fall and bulk precipitations respectively.

Nitrogen fixation by asymbiotic organism is low amounting to 1kg/ha annually,

Various shrubs my play significant rolls in N fixation.

**From (Fenn et al., 1993)**

Burning reduces the populations of nitrifier bacteria in chaparral ecosystems (Dunn et al. 1979).

**From Hanan 2017**

Fires uncouple N mobilization from uptake by destroying plant biomass and increasing nitrification.

While most biological activity shuts down in prolonged dry sesaons in Mediterranean-type ecosystems (Stark ad Firestone 1995), some basal mineralization still occures allowing NH4 to accumulate in soil microsites that remain hydrologically disconnected through the summer (Parker and Schimel 2011).

Upon wet-up, NH4 can diffuse to nitrifiers, which respond within hours of rewetting (Placella and Firestone 2013), which means that early autumn storms can generate a flush of nitrate to streams while plants are still relatively dormant (Mooney and Rundel, 1979; James and Richards, 2006; Homyak et al., 2014)

Fires supply ash rich in NH4 and easily decomposable organic N (Marion et al., 1991).

N loss is greater during both extreme wet and extreme dry years, although the impact of drought is greater.